Stormwater Report

The Arsenal Project
Arsenal Street
Watertown, MA 02472

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I. STORMWATER REPORT NARRATIVE

1.0 Introduction

RJO'Connell & Associates, Inc. (RJOC) has prepared this stormwater report on behalf of Boylston Properties and The Wilder Companies for the proposed redevelopment of The Arsenal Mall located on Arsenal Street in Watertown, Massachusetts (refer to Figure 1, "USGS Site Locus Map"). This study uses the computer program HydroCAD, version 10.00 based on the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS) TR-20 Computer Program for Project Formulation Hydrology, to model pre-redevelopment and post-redevelopment hydrologic site conditions. This report presents a comparative analysis of the pre-redevelopment hydrologic condition to the post-redevelopment condition, and demonstrates that the redeveloped condition will be a significant improvement over the pre-redevelopment condition. This report will also demonstrate the project's compliance with the *Massachusetts Stormwater Policy* and the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the maximum extent practicable.

2.0 Site Location and Description

The proposed project is located at the 693,053 square foot (15.910 acre) Mall Lot 2 – Phase A, and the 136,920 square foot (3.143 acre) Harvard Vanguard Medical Associates (HVMA) Lot 2A, both located on Arsenal Street in Watertown, Massachusetts. The parcels are identified by the Watertown Assessor's Office as 1301-2D-2 and 1301-2A-1 respectively. The site is bounded by Arsenal Street on the north, Greenough Boulevard and the Charles River on the east, Watertown park land and the Charles River on the south, and Harvard Vanguard Medical Associates on the west. The project site also encircles the Home Depot parcel located at 615 Arsenal Street. The site is currently occupied by the existing Arsenal Mall, which is comprised of a ±178,200 square foot, 2-story brick building and a ±83,140 square foot, 2-story brick building. Also located on-site are approximately 583 paved parking spaces for employees and customers.

This site is unique in that stormwater runoff from the site is directed to two differently regulated areas. Under existing conditions, runoff from the north and west portions of the site, and the adjacent HVMA parcel, discharges into the Town of Watertown's storm drain system in Arsenal Street at Point of Analysis 1 (POA-1). This drainage system is regulated by the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*. Runoff from the remaining east and south portions of the site collects in one of three drain pipes owned by the Massachusetts Department of Conservation and Recreation (DCR), which all ultimately discharge into the Charles River. The DCR is a state agency, and as such is regulated by the *Massachusetts Stormwater Policy*.

3.0 Proposed Project

The proposed project consists of the partial demolition of the two existing Arsenal Mall buildings, and the construction of six new buildings on the site. The ±178,200 square foot existing Building A will be partially demolished, with publicly accessible open space and a ±59,845 square foot proposed Building F to be constructed in its place. Existing Building A will be reduced to an approximate footprint of 83,100 square feet. The ±83,140 square foot existing building will also be partially demolished and reduced to a footprint of ±72,480 square feet with the ±1,500 square foot proposed Building E2 serving as a detached appendage. Proposed Building B will be five stories tall with an approximate footprint of 68,040 square feet. Proposed Buildings C and D will also be five stories tall with approximate footprints of 31,700 square feet and 25,600 square feet respectively. Proposed Building G will be a 13-story residential building with a footprint of approximately 15,640 square feet.

Parking will be reconfigured into primarily structured parking to provide for a more pedestrian-friendly and handicap accessible environment with only a few small surface parking lots. Three subsurface parking garages will be constructed, one below proposed Building B, one below proposed Buildings C and D, and one below proposed Building F. Two above-ground parking garages will be constructed above proposed Buildings B and F. Existing site entrances and exits off Arsenal Street will remain in their present locations, but be reconfigured to provide easier and more efficient ingress to and egress from the site.

New utilities, including water, sanitary sewer, electric, and telephone, will be installed as part of the phased construction process. Utility corridor locations will be limited due to phased construction, which is required to fulfill the terms of existing tenant leases. These leases require tenants to remain open during the first, second, or in some cases, all of the proposed construction phases.

The proposed subsurface parking garages and required utility corridors severely limit the opportunity to install infiltration Best Management Practices (BMPs). However, a stormwater management system has been designed in compliance with the *Massachusetts Stormwater Policy* and the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the maximum extent practicable. The proposed stormwater management system will reduce pre-redevelopment stormwater runoff peak flow rates and volumes, and improve runoff water quality. Runoff control, water quality improvement, and groundwater recharge will be accomplished by implementing the following drainage improvements:

- Collect storm runoff in catch basins with deep sumps and hooded outlets;
- Route runoff through oil grit separators designed to remove at least 25% TSS from the 1-inch water quality volume storm. Runoff exceeding the 1-inch water quality storm will bypass treatment without backwatering the drainage system;
- Construct two subsurface infiltration systems to detain and infiltrate runoff into the ground, thereby reducing peak flow rates and volumes of runoff discharged from the site and increasing groundwater recharge;

The proposed stormwater management measures described above will have no adverse impacts to adjacent properties, and will result in an overall benefit to the surrounding area.

4.0 Compliance with the *Massachusetts Stormwater Policy*

This redevelopment program includes a stormwater management system that will collect, pre-treat, treat, and reduce stormwater runoff in conformance with the *Massachusetts Stormwater Policy*. According to Standard 7, a redevelopment project is defined as follows:

- "Development, rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area."

As a redevelopment project, the site is required to meet Standards 2 through 6 to the maximum extent practicable and fully comply with Standards 1, 8, 9, and 10. The proposed project results in a net increase in the amount of landscaped/open area by approximately 13,000 square feet, but has been designed to fully comply with all the Stormwater Management Standards as if the site was previously undeveloped. Compliance with each Standard is described below:

Standard 1: No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

No new stormwater conveyances will be created under the proposed redevelopment program, and no untreated stormwater will discharge directly to or cause erosion in wetlands or waters of the Commonwealth. Stormwater runoff that ultimately discharges from two of the three Points of Analysis (POAs) will be collected in catch basins with deep sumps and hooded outlets, routed through oil grit separators designed to remove at least 25% TSS from the 1-inch water quality flow, and infiltrated in subsurface infiltration systems prior to discharge from the site. Runoff from the third POA will be significantly reduced under the proposed condition until a new subsurface infiltration system can be constructed on the HVMA parcel, when runoff will be eliminated from the third POA.

Standard 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The proposed stormwater management system has been designed so that post-redevelopment peak discharge rates and volumes do not exceed pre-redevelopment peak discharge rates and volumes. Subsurface Infiltration System 1 (SSI-1) has been designed to detain and infiltrate the 24-hour, 25-year, Cornell Extreme Precipitation rainfall until the HVMA lease expires, when a new subsurface infiltration system can be constructed on that parcel. After construction of the new subsurface infiltration system, SSI-1 will reduce the peak flow rate of runoff discharged from the site at Point of Analysis 1 (POA-1) by 95%. The watershed area and amount of impervious area within the watershed that discharges runoff to Point of Analysis 2 (POA-2) will be reduced, which will result in lower post-redevelopment peak discharge rates and volumes compared to pre-redevelopment rates and volumes. After construction of the future subsurface infiltration system on the HVMA parcel, the entire watershed area that previously discharged to POA-2 will be directed to SSI-1. This future condition will result in zero discharge from the site at POA-2. Subsurface Infiltration System 2 (SSI-2) has been designed to detain and infiltrate the 1-inch water quality volume over the impervious area within the proposed watershed, which will significantly reduce post-redevelopment peak discharge rates and volumes compared to pre-redevelopment rates and volumes at Point of Analysis 3.

Standard 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Annual groundwater recharge will be increased under post-redevelopment conditions by the increase in landscaped/open area by approximately 13,000 square feet and the construction of two subsurface infiltration systems. Subsurface Infiltration System 1 (SSI-1) has been designed to detain and infiltrate significantly more runoff than the required 1-inch water quality volume. Specifically, it has been designed to recharge runoff from the 24-hour, 25-year, Cornell Extreme Precipitation rainfall until the lease on the HVMA parcel expires, and a new subsurface infiltration system can be constructed. When that future subsurface infiltration system is constructed to treat runoff associated with the HVMA parcel, SSI-1 will reduce the peak flow rate of runoff discharged from the site at Point of Analysis 1 (POA-1) by 95%. Subsurface Infiltration System 2 (SSI-2) has been designed to detain and infiltrate the required 1-inch water quality volume over the impervious area within the proposed tributary watershed. The reduction of impervious area within the tributary watershed discharging to Point of Analysis 2 under post-redevelopment conditions will result in increased annual groundwater recharge compared to pre-redevelopment conditions.

Standard 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

Stormwater runoff from paved surface parking areas will be collected in catch basins with deep sumps and hooded outlets and routed through oil grit separators designed to remove at least 25% TSS from the 1-inch water quality flow prior to discharge from the site. Subsurface Infiltration Systems 1 and 2 will provide the remaining 80% TSS removal prior to discharge from the site at Points of Analysis 1 and 3.

Standard 5: For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook.

The proposed redevelopment is classified as a land use with higher potential pollutant loads (LUHPPL) due to the large-scale, mixed-use nature of the site and an anticipated parking lot with high intensity use (1,000 vehicle trips per day or more). Except for a few small surface parking lots, most parking will be provided in subsurface and above-ground garages protected from exposure to rain, snow, snowmelt, and stormwater runoff, significantly reducing the discharge of stormwater with higher potential pollutant loads from the site. Stormwater Best Management Practices (BMPs) have been selected that MassDEP has determined to be suitable for pre-treating and treating runoff from exposed parking lots and access drives on-site, including: catch basins with deep sumps and hooded outlets, oil grit separators, and infiltration systems. As a result of the implementation of these BMPs, the discharge of stormwater with high potential pollutant loads will be significantly reduced in conformance with the *Massachusetts Stormwater Policy*.

Standard 6: Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.

No portion of the site is located within a Zone I, Zone II, or Interim Wellhead Protection Area of a public water supply or any other critical area.

Standard 7: A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

The proposed project involves the redevelopment of the existing Arsenal Mall, which will result in a net decrease in impervious area on-site. However, the site has been designed to fully comply with all the Stormwater Management Standards as if the site was previously undeveloped.

Standard 8: A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

A Stormwater Pollution Prevention Plan (SWPPP) to control erosion, sedimentation, and other pollutant sources, and prevent erosion and sediments from moving off-site during construction and land disturbance activities will be finalized and submitted before construction commences. A Demolition and Erosion Control Plan will also be finalized and included in the site plan set before construction commences.

Standard 9: A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

An Operation and Maintenance Plan (O&M) with a Long Term Pollution Prevention Plan (LTPPP) has been developed and can be found in Appendix G. It will be implemented to ensure the long-term, post-construction operation of the stormwater management system.

Standard 10: All illicit discharges to the stormwater management system are prohibited.

There will be no illicit discharges to the stormwater management system, and an illicit discharge compliance statement is included in the Operation and Maintenance Plan (refer to Appendix G).

5.0 Compliance with the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*

This site is unique in that stormwater runoff is directed to two differently regulated areas. Runoff from the north and west portions of the site discharges into the Town of Watertown's storm drain system in Arsenal Street at Point of Analysis 1 (POA-1), which is regulated by the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*. Runoff from the remaining east and south portions of the site discharges to drainage pipes owned by the Massachusetts Department of Conservation and Recreation (DCR), which is regulated by the *Massachusetts Stormwater Policy*. The entire site has been designed in compliance with the *Massachusetts Stormwater Handbook*, but the stormwater management system that discharges runoff to the Town of Watertown's 30-inch storm drain in Arsenal Street at POA-1 has been designed in compliance with the more stringent Town of Watertown's *Requirements for Stormwater Management and Erosion Control*.

5.1 Stormwater Management Plan

5.1.1 Existing Conditions Plan

An Existing Conditions Plan of the site has been prepared by Feldman Land Surveyors. The plan contains sufficient information to describe the existing surface site features and subsurface utility information, and is included in the site plan set.

5.1.2 Proposed Conditions Plan

Proposed Conditions Plans of the site consisting of an Overall Site Plan, Grading and Drainage Plan, Utility Plan, and Parking and Traffic Control Plan have been prepared by RJO'Connell & Associates, Inc. and are included in the site plan set. These plans contain sufficient information to describe the proposed surface site features and subsurface utility modifications.

5.1.3 Erosion and Sediment Control Plan

A Demolition and Erosion Control Plan has been prepared by RJO'Connell & Associates, Inc. The plan is included in the site plan set, and contains sufficient information to demonstrate that erosion and sedimentation will be minimized during the construction process.

5.1.4 Construction Detail Plan

Construction Detail Plans have been prepared by RJO'Connell & Associates, Inc. to include Erosion Control Details, Drainage Details, Utility Details, and Site, Parking and Traffic Control Details. These details are included in the site plan set, and contain sufficient information for construction details.

5.1.5 Stormwater Management Report

This Stormwater Report has been prepared to document compliance with the *Massachusetts Stormwater Policy* and the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the maximum extent practicable. Compliance with the standards described in these regulations is documented in Section 4.0 and 5.0 of this report.

5.1.6 Operation and Maintenance Plan

An Operation and Maintenance Plan (O&M) that describes the various components of the proposed stormwater system, identifies inspection and maintenance tasks, and provides a schedule to follow, has been developed and can be found in Appendix G. This plan will ensure the proper long-term performance of the system.

5.2 Performance Standards

5.2.1 Retention Standard

Section 8.1 of the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* states, "For all new development and redevelopment projects, stormwater management systems must be designed such that all stormwater runoff is retained on-site to the Maximum Extent Practicable (MEP)…The intent of this standard is to provide on-site stormwater retention measures (such as infiltration) for all storm events up to and including the 100-year, 24-hour storm."

The stormwater management system that discharges runoff from the site at Point of Analysis 1 (POA-1) has been designed such that all stormwater runoff is retained on-site to the maximum extent practicable. Subsurface Infiltration System 1 (SSI-1) has been designed to retain and infiltrate runoff from the 24-hour, 25-year, Cornell Extreme Precipitation rainfall until the HVMA lease expires and a new subsurface infiltration system can be constructed on that parcel. When that future subsurface infiltration system is constructed to treat runoff associated with the HVMA parcel, SSI-1 will reduce the peak flow rate of runoff discharged from the site at POA-1 by 95%.

The stormwater management systems that discharge runoff from the site at Points of Analysis 2 and 3 (POA-2 and POA-3) have not been designed to retain and infiltrate the 24-hour, 100-year, Cornell Extreme Precipitation rainfall because at those discharge points, runoff discharges to areas owned by the Massachusetts Department of Conservation and Recreation (DCR) and is regulated by MassDEP and the *Massachusetts Stormwater Policy*.

5.2.2 Maximum Extent Practicable

This report, in conjunction with the site plan set, provides documentation to demonstrate how this redevelopment project will retain stormwater on-site to the maximum extent practicable.

- All reasonable efforts have been made to meet the applicable recharge requirements, as will be further described in the sections below.

- Several alternate stormwater measures were considered and evaluated for this redevelopment project, which proposes to implement stormwater BMPs recommended by the *Massachusetts Stormwater Handbook* for land uses with higher potential pollutant loads (LUHPPLs) including:
    - street sweeping;
    - catch basins with deep sumps and hooded outlets;
    - oil grit separators; and
    - subsurface infiltration systems.
- The aforementioned techniques will be employed where feasible, and are designed in compliance with the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the highest practicable level until the HVMA lease expires and a new subsurface infiltration system can be constructed on that parcel. The stormwater management system as designed will retain stormwater runoff volumes as summarized in Section 9.2 of this report.

5.2.3 Factors Affecting Retention Potential

The site constraints listed below severely affect the proposed drainage system's ability to fully meet the 24-hour, 100-year, Cornell Extreme Precipitation rainfall recharge requirement:

- Lack of Space: The site is located in a densely developed urban area or Watertown with a high land cost. Discharge from the site at Point of Analysis 1 is close to compliance under post-redevelopment conditions. Full compliance at this point would require a larger infiltration system footprint, which would result in significant loss of development value. This site is an example of the Town's desire to encourage density development conflicting with its goal of retaining all stormwater on-site.
- Soils: SSI-1 fully utilizes a Hydrologic Soil Group A (HSG-A) classification for the soils on the portion of the site that discharge to the Town of Watertown's drainage system.
- Groundwater: SSI-1 fully utilizes the depth to estimated seasonal high groundwater. Four feet of separation is maintained between the bottom of system and estimated seasonal high groundwater since the system is utilized for peak rate attenuation.
- Prior Contamination: Some subsurface exploration still has to be done, but no contamination has been encountered on-site to this point.
- Underground Utilities: The presence of existing and proposed underground utilities notably reduces the amount of land available for on-site stormwater management controls. Utility corridors will be forced into certain locations due to the nature of the phased construction required because of certain tenant leases. In addition to utility corridors, three subsurface parking garages significantly reduce the land available for stormwater management.

5.2.4 Criteria for Determining Maximum Extent Practicable

Section 8.4 of the Watertown *Requirements for Stormwater Management and Erosion Control* establishes the following criteria to determine if the 24-hour, 100-year, Cornell Extreme Precipitation rainfall retention standard has been met to the maximum extent practicable:

- Factors affecting retention potential, as described in Section 5.2.3 of this report, have been identified on-site and preclude the ability to fully meet the retention standard.

  - This criterion has been met; refer to Section 5.2.3 of this report.
- Appropriate measures to reduce stormwater runoff from the site have been provided through better site design practices, such as removing extraneous parking, reconfiguring required parking, minimizing the use of impervious materials, and providing enhanced vegetation.
  - This criterion has been met; refer to the site plan set.
- Appropriate measures have been taken to disconnect roof runoff from direct discharge to the drainage system.
  - This criterion has been met. Under post-redevelopment conditions, runoff from all building roofs will be directed to subsurface infiltration systems. Half of Building A will be directed to Subsurface Infiltration System 1 until the subsurface infiltration system on the HVMA parcel is built. The other half of Building A will continue along the existing drainage pattern to Point of Analysis 2 until the subsurface infiltration system on the HVMA parcel is built. Under future post-redevelopment conditions, when the subsurface infiltration system on the HVMA parcel is constructed, all of the buildings on the Mall lot and the HVMA lot will be directed to subsurface infiltration systems prior to discharge to the drainage system.
- Appropriate measures have been taken to disconnect other existing paved areas from direct discharge to the drainage system, allowing controlled flow over pervious areas or through BMPs providing at least partial recharge.
  - This criterion has been met. The project incorporates publicly accessible landscaped open space between existing Building A and proposed Building F as a connection point to access adjacent public parkland. Additionally, under future post-redevelopment conditions, when the subsurface infiltration system on the HVMA parcel is constructed, runoff from all paved areas on the Mall lot and the HVMA lot will be directed to subsurface infiltration systems prior to discharge to the drainage system.
- Appropriate measures have been taken to apply LID techniques for runoff reduction. Measures such as, but not limited to, porous pavement, green roofs, rain gardens, bioretention areas, and rainwater harvesting and reuse have been considered.
  - This criterion has been met; LID techniques have been evaluated for this site and applied to the maximum extent practicable, refer to Section 5.2.2 of this report.
- There shall be a documented reduction in the rate and volume of runoff. In no instance shall there be an increase in the rate or volume of runoff from a redeveloped site.
  - This criterion has been met; refer to Section 9.2 of this report.
- The design provides for treatment of all runoff from existing (as well as new) impervious areas to achieve the 80% TSS removal rate specified in the *Massachusetts Stormwater Policy*.
  - This criterion has been met; refer to Section 9.4 of this report.
- All other elements of the *Massachusetts Stormwater Policy* are met.
  - This criterion has been met; refer to Section 4.0 of this report.

5.2.5 Documentation of Maximum Extent Practicable

This report provides the following information illustrating that on-site stormwater management control measures have been provided to the maximum extent practicable:

- A description of the site-specific conditions that affect the ability to retain stormwater runoff.
  - This criterion has been met; refer to Section 5.2.3 of this report.
- An alternatives analysis of all LID techniques and BMPs considered to reduce and manage stormwater runoff.
  - This criterion has been met; LID techniques have been evaluated for this site and applied to the maximum extent practicable, refer to Section 5.2.2 of this report.
- Hydrologic and hydraulic estimates of stormwater runoff peak rates and total volumes from the site for the 2-, 10-, 25-, and 100-year design storms, demonstrating a documented reduction in the rate and volume of runoff. In no instance shall there be an increase in the rate or volume of runoff from a redeveloped site. A narrative explaining the degree to which stormwater runoff will be contained on-site shall accompany the estimates.
  - This criterion has been met; refer to Section 9.2 of this report.

5.2.6 Off-Site Work

Section 8.6 of the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* allows BMPs to be implemented at other locations, preferably within the same drainage area as the original redevelopment project, if all stormwater runoff cannot be retained on-site.

Subsurface Infiltration System 1 is regulated by the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*, and has been designed to hold and infiltrate the 24-hour, 25-year, Cornell Extreme Precipitation rainfall until the HVMA lease expires and a new subsurface infiltration system can be constructed on that parcel. When that future subsurface infiltration system is constructed to treat and control runoff associated with the HVMA parcel, Subsurface Infiltration System 1 (SSI-1) will reduce the peak flow rate of runoff discharged from the site at POA-1 by 95%. Since the proposed redevelopment project does not treat the full 24-hour, 100-year, Cornell Extreme Precipitation rainfall, a portion of the stormwater runoff from the Town's drainage system in Arsenal Street will be intercepted, routed through an oil grit separator, and directed to SSI-1 for infiltration. In storm events up to and including the 24-hour, 25-year, Cornell Extreme Precipitation rainfall, all of this runoff will be treated and completely infiltrated on-site.

5.2.7 Retention Waiver

Section 8.7 of the Watertown *Requirements for Stormwater Management and Erosion Control* allows the retention requirement to be entirely waived in the following instances:

- The site has been classified as contaminated;
- Contamination has been capped in place;
- An Activity and Use Limitation (AUL) precludes infiltrating runoff to the groundwater pursuant to Massachusetts General Law, Chapter 21E and the Massachusetts Contingency Plan, 310 CMR 40;
- The site contains a solid waste landfill as defined in 310 CMR 19; or
- Groundwater from the recharge area flows directly towards a solid waste or 21E site.

Subsurface exploration is still on-going on-site, but no contamination has been encountered to this point. Therefore, a "Retention Waiver" is not expected to be required to entirely waive the retention requirement.

6.0 Soil Data

Soil data has been compiled using the Natural Resources Conservation Service (NRCS) Web Soil Survey located at URL: websoilsurvey.nrcs.usda.gov. The soil survey identified the soil on the majority of the site to be Urban Land with no Hydrologic Soil Group classification. The soil in the south portion of the site closest to the Charles River is identified by the survey as Udorthents with a wet substratum and no Hydrologic Soil Group classification (refer to Figure 2, "NRCS Web Soil Survey Map").

Borings and test pits were performed on-site by McPhail Associates, LLC. These explorations, as well as sieve analyses where the proposed subsurface infiltration systems will be located, classified the soils on-site according to the summary table below (refer to Appendix B for additional soils information):

Subsurface Infiltration System	USDA Soil Classification	Recommended Rawls Infiltration Rate (in/hr)	Estimated Seasonal High Groundwater Elevation
SSI-1 (north)	HSG-A, Sand	8.27	8.0
SSI-2 (south)	HSG-B, Sandy Loam	1.02	4.0
SSI-3 (west, future)	HSG-B, Sandy Loam	1.02	7.0

7.0 Hydrologic Methodology

Existing and proposed drainage analyses were performed for the 2-, 10-, 25-, and 100-year storm events using HydroCAD version 10.00, which is based on the National Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS) Technical Release 20 (TR-20) methodology for computing peak discharges from rainfall runoff for urban and rural watersheds. The 24-hour precipitation rates from the *Town of Watertown DPW Site Plan Review On-Site Drainage Requirements* were used in the analyses for the entire site. The 24-hour precipitation rates used for each storm event are as follows:

Storm Event	24-Hour Precipitation (in)
2-Year	3.20
10-Year	4.90
25-Year	6.20
100-Year	8.90

The NRCS method uses several parameters based on watershed characteristics and configuration to generate a curvilinear unit hydrograph and produce a runoff hydrograph for the watershed.

Basic input data required to generate a hydrograph are the watershed area, storm frequency, time of concentration, 24-hour rainfall, and the watershed's runoff curve number.

NRCS Technical Release 55 (TR-55) methodology was utilized to determine weighted runoff curve number (CN) for the existing and proposed watershed areas. Inputs for obtaining the weighted CN include ground cover type and the Hydrological Soil Group (HSG), as described in Section 6.0 of this report. Time of concentration (tc) was calculated based on the most hydrologically distant point (time-wise) within the watershed, but determined to be less than six minutes. A minimum time of concentration of six minutes was utilized for modeling purposes.

Drainage catchment boundaries were established based on property lines, site topography, storm drainage layouts, and the major drainage exit points from the watershed, or Points of Analysis (POA). The pre-redevelopment watershed boundaries can be seen on Figure 6, "Pre-Redevelopment Watershed Plan", and the post-redevelopment boundaries can be seen on Figure 7, "Post-Redevelopment Watershed Plan".

8.0 Pre-Redevelopment Drainage Conditions

8.1 On-Site Resources

There are no wetlands located on-site, but the Charles River is located within 100 feet of the site. Located on the south portion of the site are a 100-foot riverfront area setback, a 150-foot local buffer zone setback, and a 200-foot riverfront area setback associated with the Charles River. There will be no earth disturbance within the 100-foot riverfront area setback. The only earth disturbance to occur within the 150-foot local buffer zone setback will be associated with the construction of a pedestrian access stairway connecting the site to Greenough Boulevard. The only earth disturbance to occur within the 200-foot riverfront area setback, in addition to the pedestrian access stairway, will be the construction of proposed Subsurface Infiltration System 2.

The site is located outside the 100-year flood zone according to Federal Emergency Management Agency (FEMA) FIRM panels 25017C0557E and 25017C0556E effective on 6/4/2010 (refer to Figure 3, "FEMA Flood Insurance Rate Map"). There are no endangered species habitats located within or near the site (refer to Figure 4, "Natural Heritage and Endangered Species Program Map"). No portion of the site is located within an Interim Wellhead Protection Area (IWPA), a Zone I Wellhead Protection Area, or a Zone II Wellhead Protection Area (refer to Figure 5, "Wellhead Protection Map").

8.2 Pre-Redevelopment Hydrology

The site was analyzed as five separate catchment areas flowing to four Points of Analysis (POAs) based on site topography, storm drainage layouts, and property lines. This site is unique in that its stormwater runoff is directed to two differently regulated areas. Runoff from the north and west portions of the site, and the adjacent HVMA parcel, discharges into the Town of Watertown's 30-inch storm drain in Arsenal Street (POA-1), which is regulated by the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*. Runoff from the remaining east and south portions of the site is collected in one of three drain pipes owned by the Massachusetts Department of Conservation and Recreation (DCR), which all ultimately discharge into the Charles River. As a state agency, the DCR is subject to the *Massachusetts Stormwater Policy*. Aside from catch basins, there are no existing water quality or infiltration measures anywhere on-site (refer to Figure 6, "Pre-Redevelopment Watershed Plan").

Watertown Stormwater

Existing Catchment Area 1A (EX-1A)
This ±7.35 acre catchment area makes up the northern portion of the site. Included in this catchment area are grass landscaped areas, building roofs, and paved parking areas. Stormwater runoff is collected in catch basins and roof drains, which discharge the untreated stormwater into the Town of Watertown's storm drain system in Arsenal Street (POA-1).

Based on a letter prepared by Linenthal Eisenberg Anderson, Inc. Engineers (LEA), dated September 13, 1985, there are eight leaching catch basins were installed along the northern edge of the parking lot adjacent to Arsenal Street circa 1985 (refer to Appendix C for Letter prepared by LEA). These catch basins were designed in accordance with *U.S. Weather Bureau Technical Paper No. 40* for a 10-year, 30-minute rainfall frequency producing 4.18 inches of precipitation and an initial 15-minute time of concentration. Four of the catch basins are interconnected by a 12-inch perforated vitrified clay overflow pipe connecting to the 30-inch drain pipe that leaves the site. These catch basins ultimately overflow into the Town of Watertown's storm drain system in Arsenal Street, and are accounted for in EX-1A. The remaining four leaching catch basins are not interconnected, and have no overflow pipe. In any rain storm exceeding 4.18 inches of precipitation, these four leaching catch basins will fill to capacity, flood out of the rim onto the parking lot, and overflow into the Town of Watertown's drainage system in Arsenal Street that does not connect to POA-1. The catchment area that drains to these four leaching catch basins has been excluded from this drainage analysis.

Existing Catchment Area 1B (EX-1B)
This ±2.41 acre catchment area makes up the loading area for existing Building A and the adjacent HVMA parcel. Included in this catchment area are grass landscaped areas, building roofs, and paved parking areas. Stormwater runoff is collected in catch basins and roof drains, which discharge the untreated stormwater into the Town of Watertown's storm drain system in Arsenal Street (POA-1).

DCR Stormwater

Existing Catchment Area 2 (EX-2)
This ±4.57 acre catchment area makes up the southern portion of the site, and is mostly building roof area with small areas of paved access drives and grassed landscape areas. Stormwater runoff is collected in catch basins and roof drains that convey untreated stormwater through the DCR's 15-inch drain pipe south of existing Building A (POA-3). This runoff ultimately discharges into the Charles River.

Existing Catchment Area 3A (EX-3A)
This ±2.32 acre catchment area makes up the eastern portion of the site. Included in this catchment area are grass landscaped areas, building roofs, and paved parking areas. Stormwater runoff is collected in catch basins and roof drains that convey untreated stormwater to the DCR's

24-inch drain pipe adjacent to Greenough Boulevard (POA-3A), which ultimately discharges into the Charles River.

Home Depot Existing Catchment Area 3B (HDEX-3B)
This ±1.72 acre catchment area makes up a portion of the Home Depot parking area that will be intercepted by proposed Subsurface Infiltration System 2. Included in this catchment area are grass landscaped areas and paved parking areas. Stormwater runoff is collected in catch basins, flows through the DCR's 18-inch drain pipe adjacent to Greenough Boulevard (POA-2B), and ultimately discharges into the Charles River.

8.3 Pre-Redevelopment Hydrological Conditions

Below are summary tables of the pre-redevelopment peak flow rates and volumes of runoff at the Points of Analysis. As previously mentioned, the flows from POA-1 are regulated by the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*, and the flows from POA-2 and POA-3 are regulated by the *Massachusetts Stormwater Policy*.

Existing Peak Rates of Runoff in Cubic Feet per Second (cfs)

Location	Weighted CN	Storm Event			
		2-Year	10-Year	25-Year	100-Year
POA-1	92	25.88	42.57	55.20	81.16
POA-2	96	13.41	21.05	26.85	38.82
POA-3[1]	94	11.23	18.08	23.26	33.93

[1] POA-3 combines flows from POA-3A (24-inch pipe) and POA-3B (18-inch pipe).

Existing Runoff Volumes in Acre-Feet (ac-ft)

Location	Weighted CN	Storm Event			
		2-Year	10-Year	25-Year	100-Year
POA-1	92	1.932	3.268	4.304	6.475
POA-2	96	1.047	1.689	2.182	3.207
POA-3[1]	94	0.851	1.411	1.843	2.745

[1] POA-3 combines flows from POA-3A (24-inch pipe) and POA-3B (18-inch pipe).

Comprehensive hydrological computations for pre-redevelopment conditions are included in Appendix D.

9.0 Post-Redevelopment Drainage Conditions

9.1 Post-Redevelopment Hydrology

Similar to existing drainage conditions, runoff from the north and west portions of the site will be directed to Point of Analysis 1 (POA-1) as regulated by the Town of Watertown's *Requirements for Stormwater Management and Erosion Control*, and runoff from the south and east portions of the site will be directed to Points of Analysis 2 and 3 (POA-2 and POA-3) as regulated by the *Massachusetts Stormwater Policy*. The installation of two subsurface infiltration systems and numerous drainage structures will result in significant improvements to the existing drainage conditions. Runoff from Proposed Catchment Areas 1A and 1B will be treated by oil grit separators and directed to Subsurface Infiltration System 1. The proposed program will reduce the watershed area and amount of impervious area within Proposed Catchment Area 2, which results in a reduction of peak flow rates and volumes of runoff leaving the site at Point of Analysis 2. Additional drainage improvements will be implemented when the HVMA lease expires, and a new subsurface infiltration system can be constructed on that parcel. When that subsurface infiltration system is constructed, all of Proposed Catchment Area 2 will be directed to Subsurface Infiltration System 1, and there will be zero discharge from the site at Point of Analysis 2. Runoff from Proposed Catchment Areas 3A and 3B will be treated by oil grit separators and directed to Subsurface Infiltration System 2 (refer to Figure 7, "Post-Redevelopment Watershed Plan").

Watertown Stormwater

The Town of Watertown's *Requirements for Stormwater Management and Erosion Control* state that "stormwater management systems must be designed such that all stormwater runoff is retained on-site to the Maximum Extent Practicable". Watertown's regulations also require that drainage analyses use 24-hour rainfall data from the web tool *Extreme Precipitation in New York and New England* as developed by the Northeast Regional Climate Center (NRCC) at Cornell University and the Natural Resources Conservation Service (NRCS). The 24-hour precipitation rates used for the analyses in accordance with Watertown's regulations can be found in the table in Section 7.0 of this report. These precipitation rates were used, not only for the areas of the site that discharge to the Town of Watertown's drainage system, but also to the DCR's drainage system.

<u>Proposed Catchment Area 1A (PR-1A)</u>
This ±9.04 acre catchment area makes up the northern portion of the site and intercepts a portion of the Town's runoff from Arsenal Street to be treated on-site. Included in this catchment area are grass landscaped areas, building roofs, and paved parking areas. Stormwater runoff is collected in catch basins and roof drains and directed through oil grit separators to achieve 44% TSS removal prior to discharge to Subsurface Infiltration System 1 (SSI-1). SSI-1 has been designed in accordance with the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the maximum extent practicable. SSI-1 will detain and infiltrate the 24-hour, 25-year, Cornell Extreme Precipitation rainfall under post-redevelopment conditions and future post-redevelopment conditions. An outlet control structure directs any overflow from the system during storm events larger than the 25-year Cornell Extreme Precipitation rainfall to the Town of Watertown's 30-inch storm drain in Arsenal Street (POA-1).

<u>Proposed Catchment Area 1B (PR-1B)</u>
This ±2.67 acre catchment area makes up the loading area for existing Building A and the HVMA lot. It includes grass landscaped areas, building roofs, and paved parking areas. Stormwater runoff is collected in catch basins and roof drains and directed through oil grit separators to achieve 44% TSS removal prior to discharge to Subsurface Infiltration System 1 (SSI-1) under post-redevelopment conditions. This catchment area is being temporarily directed to SSI-1 until the HVMA lease expires and a new subsurface infiltration system can be constructed on the HVMA parcel to treat the runoff associated with that parcel. When the runoff from PR-1B is directed to the future HVMA subsurface infiltration system, SSI-1 will be sized to reduce the peak flow rate of runoff discharged from the site at Point of Analysis 1 (POA-1) by 95% and reduce the total runoff volume from the site at POA-1 by 97%.

DCR Stormwater

The DCR is a state agency and as such, is subject to the *Massachusetts Stormwater Policy*. The *Massachusetts Stormwater Policy* requires that drainage analyses use 24-hour rainfall data as published by the Natural Resources Conservation Service (NRCS). Although significantly smaller precipitation rates could be utilized to design the drainage system flowing to DCR outlets, the larger Cornell extreme precipitation rates were used to design the drainage system for the entire site.

As a redevelopment project, this work is subject to the *Massachusetts Stormwater Policy* to the maximum extent practicable. However, the on-site drainage system that directs stormwater runoff to the DCR system has been designed to fully comply with all the Stormwater Management Standards as if the site was previously undeveloped. It is anticipated that the parking lot will generate high-intensity-uses with over 1,000 vehicle trips per day, which would classify this project as a land use with higher potential pollutant load (LUHPPL). The stormwater management system has been designed so the water quality treatment train provides 80% TSS removal prior to discharge from the site and 44% TSS removal prior to discharge to Subsurface Infiltration System 2 (SSI-2). SSI-2 has been sized to reduce peak flow rates and volumes, and to treat the required water quality volume of 1-inch over the impervious area within the proposed watershed.

Proposed Catchment Area 2 (PR-2)
This ±1.32 acre catchment area makes up the southern portion of the site, and will remain mostly building roof area with small areas of paved access drives and grass landscaped areas. Stormwater runoff is collected in catch basins and discharges to the DCR's 15-inch drain pipe at the south property line adjacent to the Watertown park land (POA-2). This catchment area, and the impervious area within, has been reduced under post-redevelopment conditions so that peak discharge rates and volumes are reduced compared to pre-redevelopment conditions in accordance with the *Massachusetts Stormwater Policy*. Under future post-redevelopment conditions, all of PR-2 will be directed to Subsurface Infiltration System 1, and there will be zero discharge from the site at POA-2.

Proposed Catchment Area 3A (PR-3A)
This ±3.74 acre catchment area makes up the eastern portion of the site and a portion of the Home Depot parking area that will discharge to Subsurface Infiltration System 2 (SSI-2). Included in this catchment area are grass landscaped areas, building roofs, and paved parking areas. Stormwater runoff is collected in catch basins and roof drains and directed through an oil grit separator to achieve 44% TSS removal prior to discharge to SSI-2. SSI-2 has been designed in accordance with *Massachusetts Stormwater Policy* to treat and recharge 1-inch of runoff over the total impervious area within PR-3A and HDPR-3B and reduce peak discharge rates and volumes compared to pre-redevelopment conditions. Two outlet control structures will control and direct overflow from SSI-2 to the DCR's 24-inch drain pipe (POA-3A) and the 18-inch drain pipe (POA-3B) adjacent to Greenough Boulevard, both of which ultimately discharge into the Charles River.

Home Depot Proposed Catchment Area 3B (HDPR-3B)
This ±1.54 acre catchment area consists of a portion of the Home Depot parking area that will discharge to proposed Subsurface Infiltration System 2 (SSI-2). Included in this catchment area

are grass landscaped areas and paved parking areas. Stormwater runoff is collected in catch basins and directed through an existing oil grit separator to achieve 44% TSS removal prior to discharge to SSI-2. SSI-2 has been designed in accordance with *Massachusetts Stormwater Policy* to treat and recharge 1-inch of runoff over the total impervious area within PR-3A and HDPR-3B, and reduce peak discharge rates and volumes compared to pre-redevelopment conditions. Two outlet control structures will control and direct overflow from SSI-2 to the DCR's 24-inch drain pipe (POA-3A) and the 18-inch drain pipe (POA-3B) adjacent to Greenough Boulevard, which discharge into the Charles River.

9.2 Post-Redevelopment Hydrological Conditions

Under post-redevelopment conditions, two new subsurface infiltration systems will be constructed to detain and infiltrate runoff from the site. SSI-1 is designed in accordance with the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the maximum extent practicable, and SSI-2 is designed in accordance with the *Massachusetts Stormwater Policy*. The tables below summarize how construction of these subsurface infiltration systems will result in reduced peak rates and volumes of runoff leaving the site at the Points of Analysis under post-redevelopment conditions compared to pre-redevelopment conditions.

Point of Analysis 1 – Watertown Storm Drain System
Pre- and Post-Redevelopment Peak Rates of Runoff in Cubic Feet per Second (cfs)

Storm Frequency	Existing Flow Rate (cfs)	Proposed Flow Rate (cfs)	Change (cfs)	% Reduction
2-Year	25.88	0.00	-25.88	100%
10-Year	42.57	0.00	-42.57	100%
25-Year	55.20	0.00	-55.20	100%
100-Year	81.16	13.43	-67.73	83%

Point of Analysis 1 – Watertown Storm Drain System
Pre- and Post-Redevelopment Runoff Volumes in Acre-Feet (ac-ft)

Storm Frequency	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Change (ac-ft)	% Reduction
2-Year	1.932	0.000	-1.932	100%
10-Year	3.268	0.000	-3.268	100%
25-Year	4.304	0.000	-4.304	100%
100-Year	6.475	0.559	-5.916	91%

Point of Analysis 2 – DCR Storm Drain System
Roof Drainage – Half of Existing Building A
Pre- and Post-Redevelopment Peak Rates of Runoff in Cubic Feet per Second (cfs)

Storm Frequency	Existing Flow Rate (cfs)	Proposed Flow Rate (cfs)	Change (cfs)	% Reduction
2-Year	13.41	3.49	-9.92	74%
10-Year	21.05	5.76	-15.29	73%
25-Year	26.85	7.47	-19.38	72%
100-Year	38.82	11.00	-27.82	72%

Point of Analysis 2 – DCR Storm Drain System
Roof Drainage – Half of Existing Building A
Pre- and Post-Redevelopment Runoff Volumes in Acre-Feet (ac-ft)

Storm Frequency	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Change (ac-ft)	% Reduction
2-Year	1.047	0.259	-0.788	75%
10-Year	1.689	0.440	-1.249	74%
25-Year	2.182	0.581	-1.601	73%
100-Year	3.207	0.875	-2.332	73%

Point of Analysis 3 – DCR Storm Drain System
Combines flows from POA-3A (24" pipe) and POA-3B (18" pipe)
Pre- and Post-Redevelopment Peak Rates of Runoff in Cubic Feet per Second (cfs)

Storm Frequency	Existing Flow Rate (cfs)	Proposed Flow Rate (cfs)	Change (cfs)	% Reduction
2-Year	11.23	0.51	-10.72	95%
10-Year	18.08	6.69	-11.39	63%
25-Year	23.26	12.74	-10.52	45%
100-Year	33.93	21.26	-12.67	37%

Point of Analysis 3 – DCR Storm Drain System
Combines flows from POA-3A (24" pipe) and POA-3B (18" pipe)
Pre- and Post-Redevelopment Runoff Volumes in Acre-Feet (ac-ft)

Storm Frequency	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Change (ac-ft)	% Reduction
2-Year	0.851	0.101	-0.750	88%
10-Year	1.411	0.681	-0.730	52%
25-Year	1.843	1.158	-0.685	37%
100-Year	2.745	2.208	-0.537	20%

Comprehensive hydrological computations for post-redevelopment conditions are included in Appendix D.

Future Post-Redevelopment Hydrological Conditions
After Construction of the Subsurface Infiltration System on the HVMA Parcel

Future Point of Analysis 1 – Watertown Storm Drain System
Pre- and Post-Redevelopment Peak Rates of Runoff in Cubic Feet per Second (cfs)

Storm Frequency	Existing Flow Rate (cfs)	Proposed Flow Rate (cfs)	Change (cfs)	% Reduction
2-Year	25.88	0.00	-25.88	100%
10-Year	42.57	0.00	-42.57	100%
25-Year	55.20	0.00	-55.20	100%
100-Year	81.16	4.28	-76.88	95%

Future Point of Analysis 1 – Watertown Storm Drain System
Pre- and Post-Redevelopment Runoff Volumes in Acre-Feet (ac-ft)

Storm Frequency	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Change (ac-ft)	% Reduction
2-Year	1.932	0.000	-1.932	100%
10-Year	3.268	0.000	-3.268	100%
25-Year	4.304	0.000	-4.304	100%
100-Year	6.475	0.168	-6.307	97%

Future Point of Analysis 2 – DCR Storm Drain System
Zero Discharge from Site
Pre- and Post-Redevelopment Peak Rates of Runoff in Cubic Feet per Second (cfs)

Storm Frequency	Existing Flow Rate (cfs)	Proposed Flow Rate (cfs)	Change (cfs)	% Reduction
2-Year	13.41	0.00	-13.41	100%
10-Year	21.05	0.00	-21.05	100%
25-Year	26.85	0.00	-26.85	100%
100-Year	38.82	0.00	-38.82	100%

Future Point of Analysis 2 – DCR Storm Drain System
Zero Discharge from Site
Pre- and Post-Redevelopment Runoff Volumes in Acre-Feet (ac-ft)

Storm Frequency	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Change (ac-ft)	% Reduction
2-Year	1.047	0.000	-1.047	100%
10-Year	1.689	0.000	-1.689	100%
25-Year	2.182	0.000	-2.182	100%
100-Year	3.207	0.000	-3.207	100%

Future Point of Analysis 3 – DCR Storm Drain System
Combines flows from POA-3A (24" pipe) and POA-3B (18" pipe)
Pre- and Post-Redevelopment Peak Rates of Runoff in Cubic Feet per Second (cfs)

Storm Frequency	Existing Flow Rate (cfs)	Proposed Flow Rate (cfs)	Change (cfs)	% Reduction
2-Year	11.23	0.51	-10.72	95%
10-Year	18.08	6.69	-11.39	63%
25-Year	23.26	12.74	-10.52	45%
100-Year	33.93	21.26	-12.67	37%

Future Point of Analysis 3 – DCR Storm Drain System
Combines flows from POA-3A (24" pipe) and POA-3B (18" pipe)
Pre- and Post-Redevelopment Runoff Volumes in Acre-Feet (ac-ft)

Storm Frequency	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Change (ac-ft)	% Reduction
2-Year	0.851	0.101	-0.750	88%
10-Year	1.411	0.681	-0.730	52%
25-Year	1.843	1.158	-0.685	37%
100-Year	2.745	2.208	-0.537	20%

Comprehensive hydrological computations for future post-redevelopment conditions are included in Appendix D.

9.3 Groundwater Recharge

Because the amount of landscaped/open area is increased by approximately 13,000 square feet under post-redevelopment conditions, the annual recharge of groundwater will be increased compared to pre-redevelopment conditions. Furthermore, because the Town of Watertown's *Requirements for Stormwater Management and Erosion Control* require all stormwater runoff to be retained on-site to the maximum extent practicable, the installation of the proposed subsurface infiltration systems will provide additional storage to significantly increase the amount of annual groundwater recharge on-site compared to pre-redevelopment conditions.

Groundwater Recharge Provided:

Subsurface Infiltration System	Elevation	Estimated Seasonal High Groundwater	Recommended Rawls Infiltration Rate (in/hr)	Total Recharge Volume Provided (cf)
SSI-1 (north)	12.0 – 25.0	8.0	8.27 (Sand)	129,080
SSI-2 (south)	8.0 – 14.0	4.0	1.02 (Sandy Loam)	56,365
Total Volume Provided				**185,445**

Drawdown Time

The *Massachusetts Stormwater Policy* states that the minimum required recharge volume should infiltrate within 72 hours. The drawdown analysis is performed by dividing the storage volume of the infiltration system by the product of the recommended Rawls infiltration rate of the existing soils beneath the system and the bottom area of the system.

$$Time_{drawdown} = \frac{R_v}{(K)(Bottom\ Area)}$$

Where:
R_v = Recharge BMP Storage Volume
K = Recommended Rawls Infiltration Rate
Bottom Area = Bottom Area of Recharge BMP

Subsurface Infiltration System 1

$$Time_{drawdown} = \frac{129{,}080\ cf}{\left(8.27\ {}^{in}/_{hr}\right)\left({}^{1\ ft}/_{12\ in}\right)(66.0\ ft)(222.0\ ft)} = 12.8\ hours$$

Subsurface Infiltration System 2

$$Time_{drawdown} = \frac{56{,}365\ cf}{\left(1.02\ {}^{in}/_{hr}\right)\left({}^{1\ ft}/_{12\ in}\right)(44.5\ ft)(317.0\ ft)} = 47.0\ hours$$

9.4 Stormwater Quality

As a land use with higher potential pollutant load (LUHPPL), the site is required to provide 44% Total Suspended Solids (TSS) removal prior to discharge to the infiltration BMP and 80% TSS removal from new impervious areas prior to discharge from the site. The water quality volume from the redeveloped site will undergo treatment to the maximum extent practicable through the use of structural and non-structural Best Management Practices (BMPs). Runoff from paved surface parking lot areas will be pre-treated to remove 44% of the TSS prior to infiltration in the subsurface systems in accordance with the *Massachusetts Stormwater Policy*. The following BMP's were selected to remove 80% of the average annual post-construction load of TSS from stormwater runoff:

- Street Sweeping
  Sweeping will be performed routinely, at least monthly, within the parking lot and driveway areas to reduce sediments and trash before they can enter the catch basins. Refer to Appendix E for performance data.
- Catch Basins with Deep Sumps and Hooded Outlets
  Stormwater runoff from pavement areas will be directed via curbing and site grading to catch basins with deep sumps and hooded outlets. Catch basins trap and remove sediments and larger particles from stormwater runoff and improve the performance of subsequent BMP's. The catch basin sumps will be a minimum of 4 feet in depth, and a

regular inspection and cleaning schedule will be followed to ensure optimal effectiveness. When properly constructed and maintained, catch basins with deep sumps and hooded outlets are effective in reducing the sediment and pollutant load in runoff. Refer to Appendix E for performance data.

- Oil Grit Separators
  Oil grit separators are precast concrete structures designed to remove settleable solids and floating contaminants from stormwater runoff. Although it varies by manufacturer, they are typically designed to remove at least 25% TSS for the 1-inch water quality flow. Low storm flows are directed into a treatment chamber where floatables and neutrally buoyant debris are trapped and settleable solids sink to the sump of the structure. Larger flows are controlled by an internal diversion weir, which directs high intensity storm events around the treatment chamber to the drainage system does not backwater. Runoff from paved surface parking areas will be routed through oil grit separators prior to discharge into SSI-1 and SSI-2. Refer to Appendix E for performance data.
- Subsurface Infiltration Systems
  Stormwater runoff will be directed into two subsurface infiltration systems after being pre-treated by catch basins with deep sumps and hooded outlets and oil grit separators. SSI-1 has been designed to detain and infiltrate runoff from the 24-hour, 25-year, Cornell Extreme Precipitation rainfall. When the new HVMA subsurface infiltration system is constructed, SSI-1 will reduce the peak flow rate of runoff discharged from the site at Point of Analysis 1 (POA-1) by 95% and reduce the total runoff volume from the site at POA-1 by 97%. SSI-2 has been designed to detain and infiltrate more than 1-inch of runoff over the total impervious area within its post-redevelopment watershed, as well as reduce peak rates and volumes of runoff discharging from the site compared to pre-redevelopment conditions. Refer to Appendix E for performance data.

TSS Removal Calculation Worksheet Table

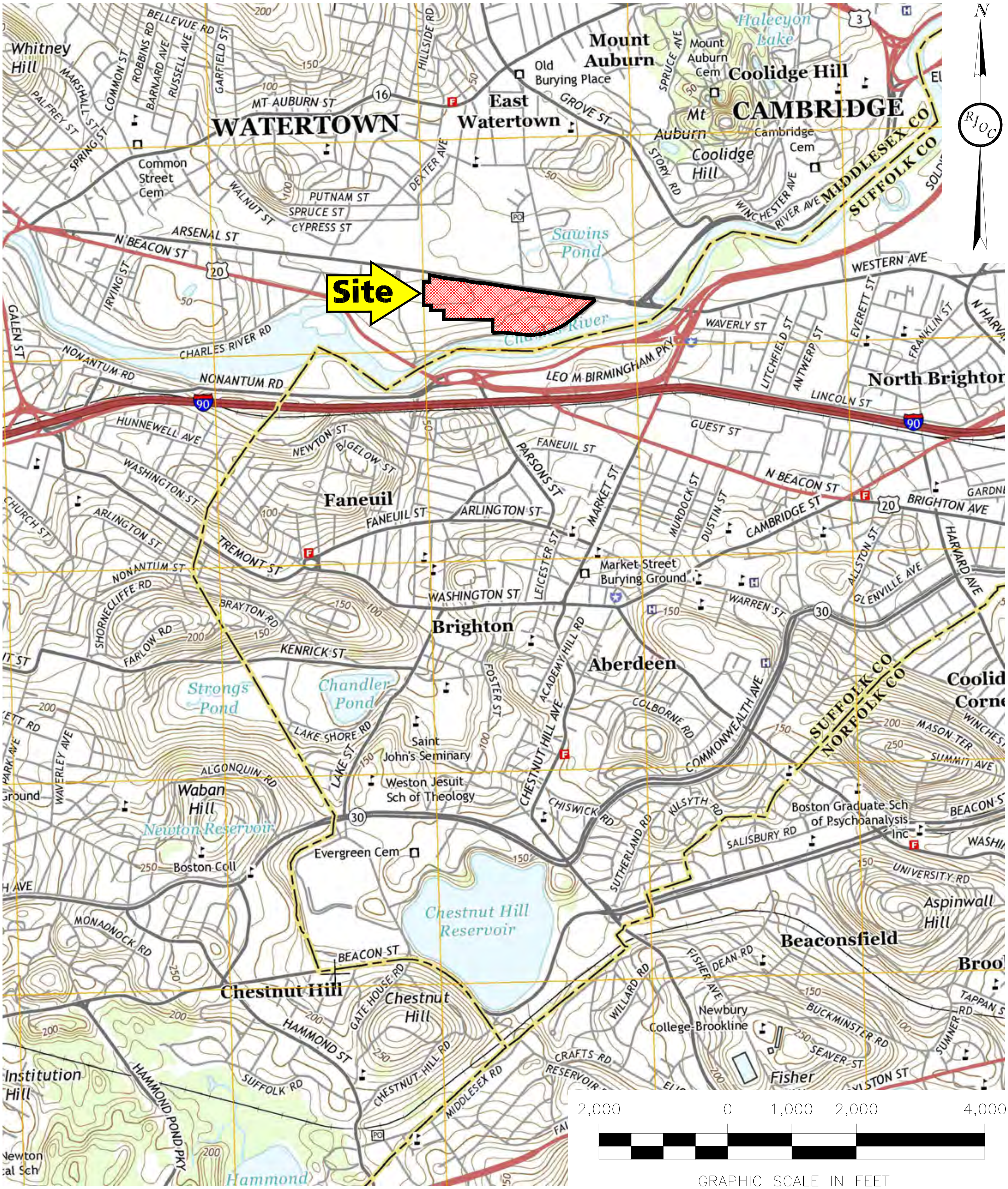
BMP (A)	TSS Removal Rate (B)	Starting TSS Load (C)	Amount Removed (B×C) (D)	Remaining Load (C-D) (E)
Street Sweeping	0.05	1.00	0.05	0.95
Catch Basins with Deep Sumps and Hooded Outlets	0.25	0.95	0.24	0.71
Oil Grit Separators	0.25	0.71	0.18	0.53
Subsurface Infiltration Systems	0.80	0.53	0.42	0.11
Total TSS Removal = Summation of (D) =			**89%**	

10.0 Summary

The stormwater management system for the proposed redevelopment includes measures for collecting, controlling, and treating stormwater runoff from the site. The drainage improvements proposed herein will reduce stormwater runoff peak flow rates and volumes leaving the site, increase groundwater recharge, and improve storm runoff water quality. The proposed measures under the redeveloped conditions comply with the *Massachusetts Stormwater Policy* and the

Town of Watertown's *Requirements for Stormwater Management and Erosion Control* to the maximum extent practicable, and represents an improvement over pre-redevelopment conditions. Implementing the inspection and maintenance program outlined in the Operation and Maintenance Plan will ensure the long term performance of the drainage system.

II. FIGURES



No.	REVISION	DATE

Designed by: JJS
Drawn by: BMS
Checked by: SPG/RWS
Scale: 1"=2,000'
Date: 07/11/2016

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Project Name:
THE ARSENAL PROJECT
WATERTOWN, MA

Drawing Name:
USGS SITE LOCUS MAP

Drawing No.:
FIG-1

Project No.: 16041

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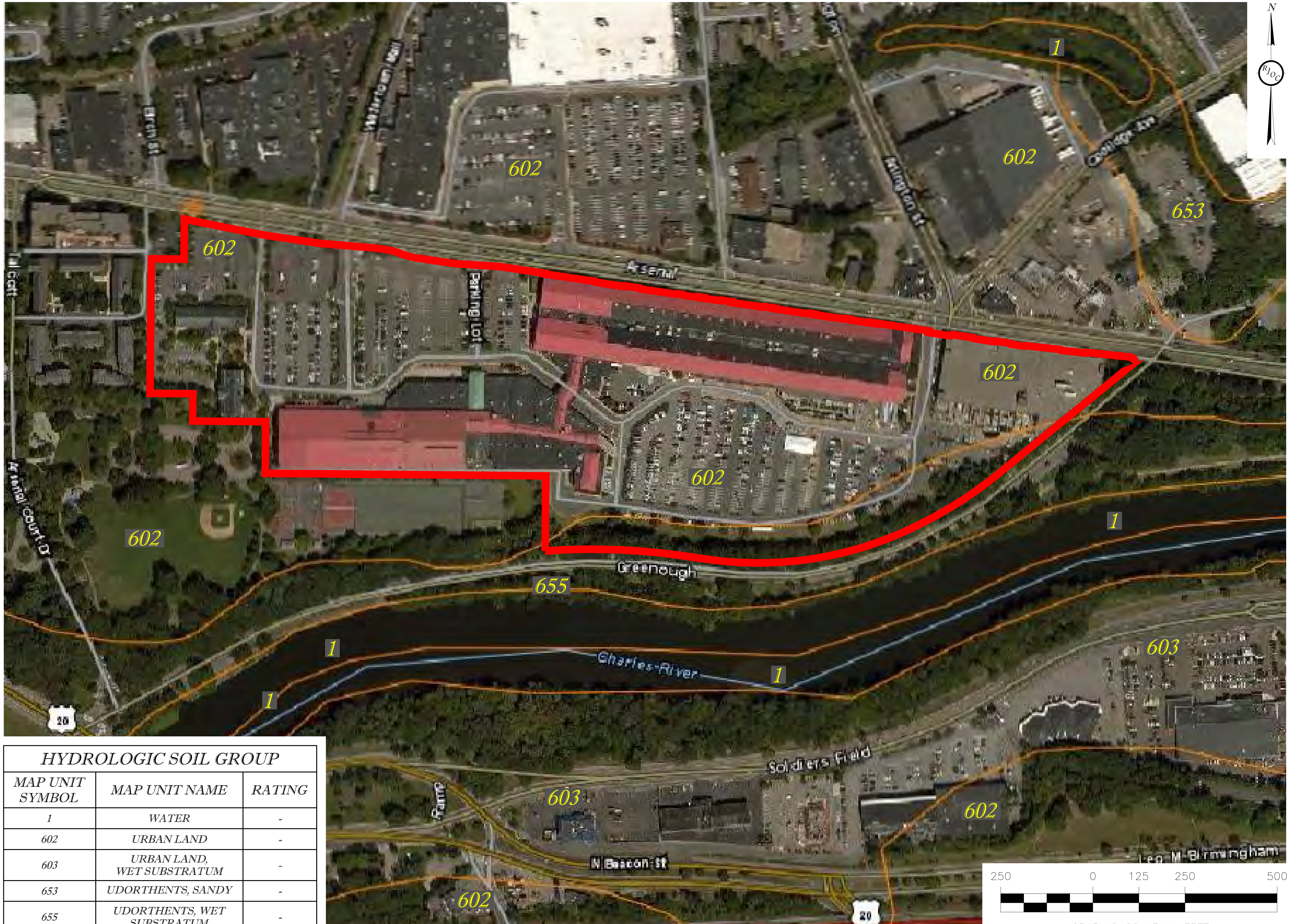

HYDROLOGIC SOIL GROUP

MAP UNIT SYMBOL	MAP UNIT NAME	RATING
1	WATER	-
602	URBAN LAND	-
603	URBAN LAND, WET SUBSTRATUM	-
653	UDORTHENTS, SANDY	-
655	UDORTHENTS, WET SUBSTRATUM	-

No.	Revision	Date

Designed by: JJS
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Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

Drawing Name:

NRCS WEB SOIL SURVEY MAP

Drawing No.:

FIG-2

Project No.: 16041

Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-2 Soils Map.dwg
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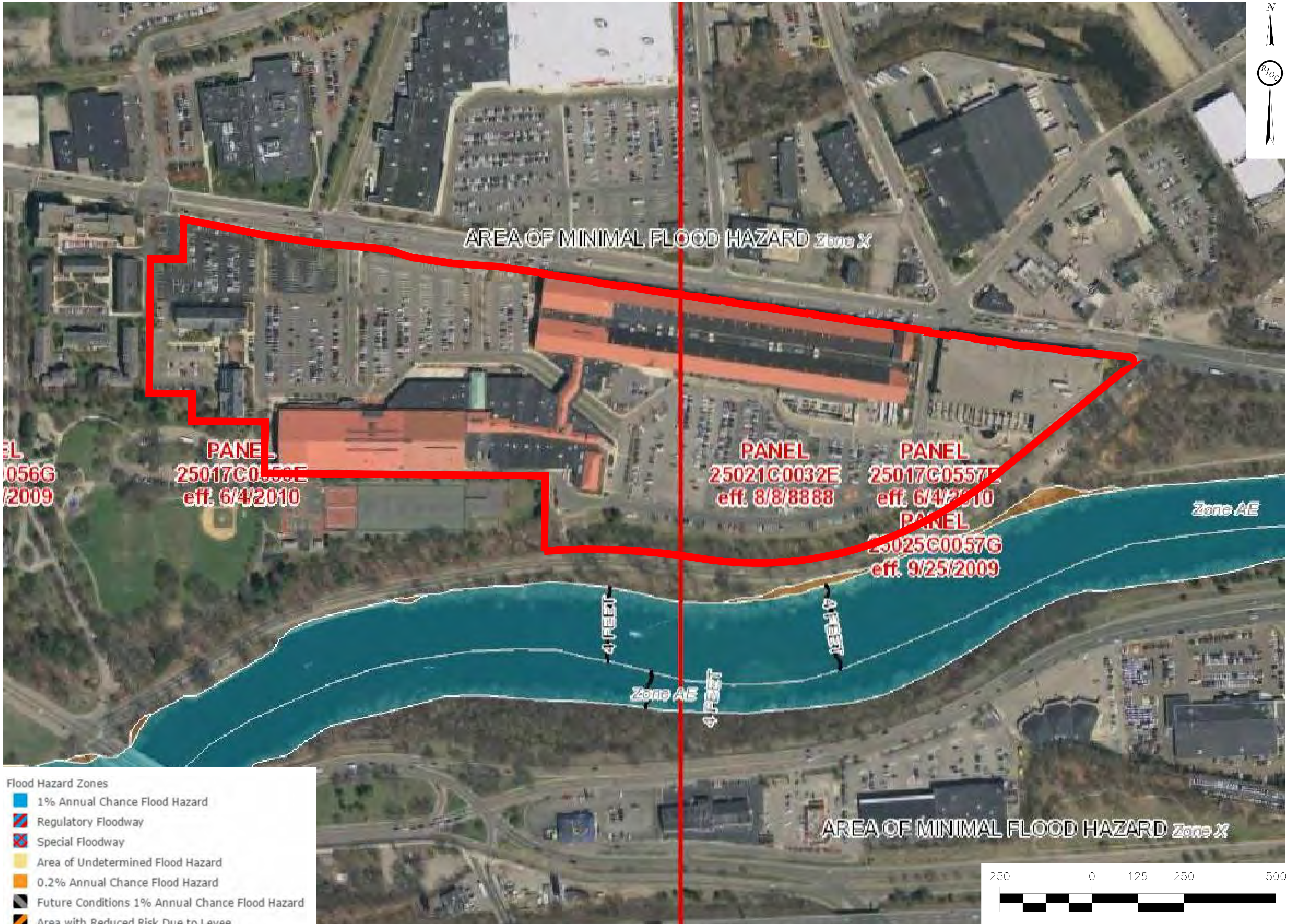

No.	Revision	Date

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BOSTON, MA 02199
PHONE: 617-262-4646

Prepared By:

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80 MONTVALE AVE
STONEHAM, MA 02180
PHONE: 781-279-0180
FAX: 781-279-0173

Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

Drawing Name:

FEMA FLOOD INSURANCE RATE MAP

Drawing No.:

FIG-3

Project No.: 16041

Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-3 FEMA Map.dwg
Jun 23, 2016 – 17:09pm

Legend

NHESP Ecoregions

NONE

NHESP Natural Communities

NONE

NHESP Estimated Habitats of Rare Wildlife

NONE

NHESP Priority Habitats of Rare Species

NONE

NONE

Potential Vernal Pools

NONE

NHESP Certified Vernal Pools

NONE

250 0 125 250 500

GRAPHIC SCALE IN FEET

Designed by:	JJS
Drawn by:	BMS
Checked by:	SPG/RWS
Scale:	1"=250'
Date:	07/11/2016

Date | Revision | No.

Prepared For:

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Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

Drawing Name:

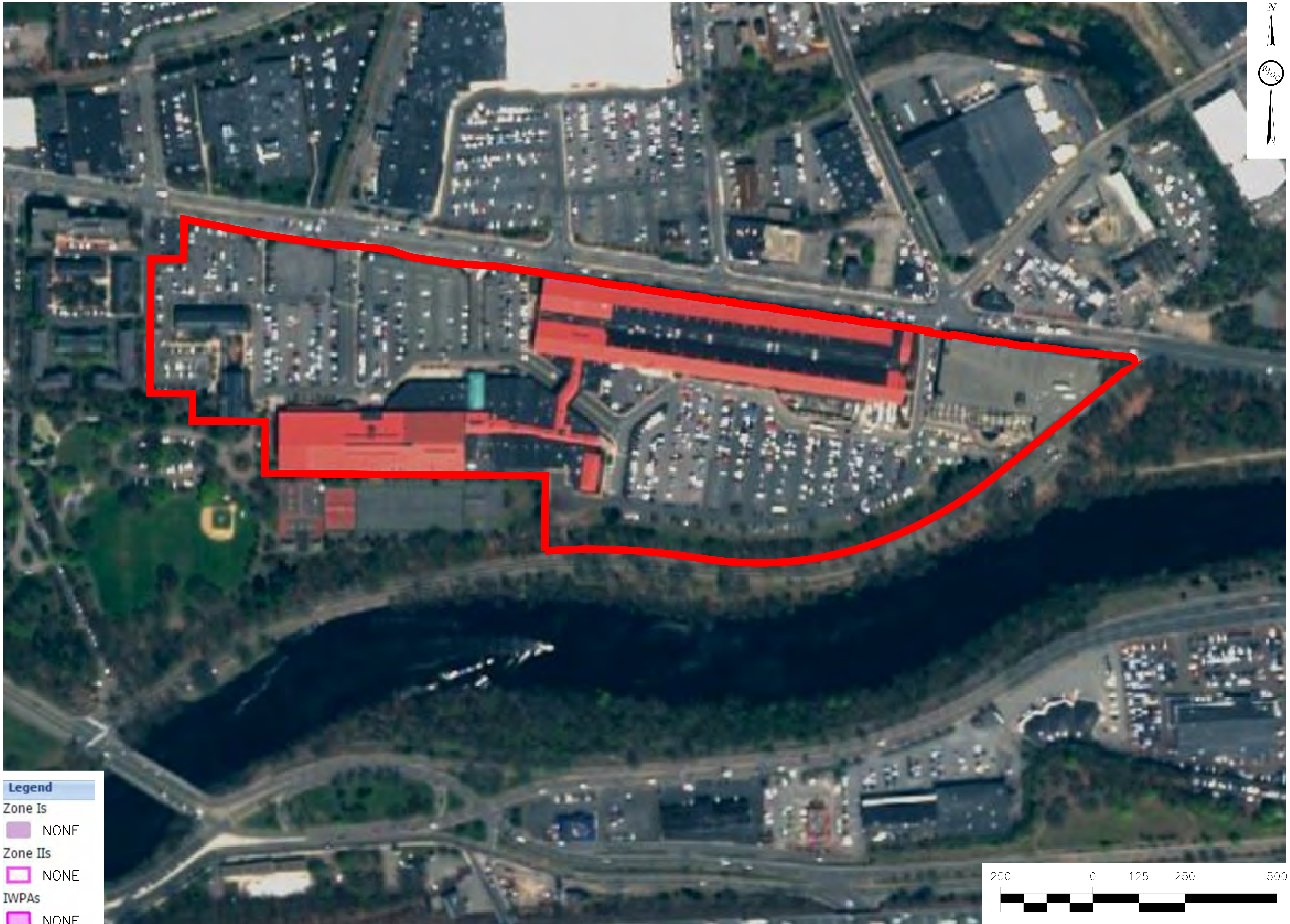
NATURAL HERITAGE AND ENDANGERED SPECIES PROGRAM MAP

Drawing No.:

FIG-4

Project No.: 16041

Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-4 NHESP Map.dwg
Jun 23, 2016 - 17:10pm



Date	Revision	No.

Designed by:	JJS
Drawn by:	BMS
Checked by:	SPG/RWS
Scale:	1"=250'
Date:	07/11/2016

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Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

Drawing Name:

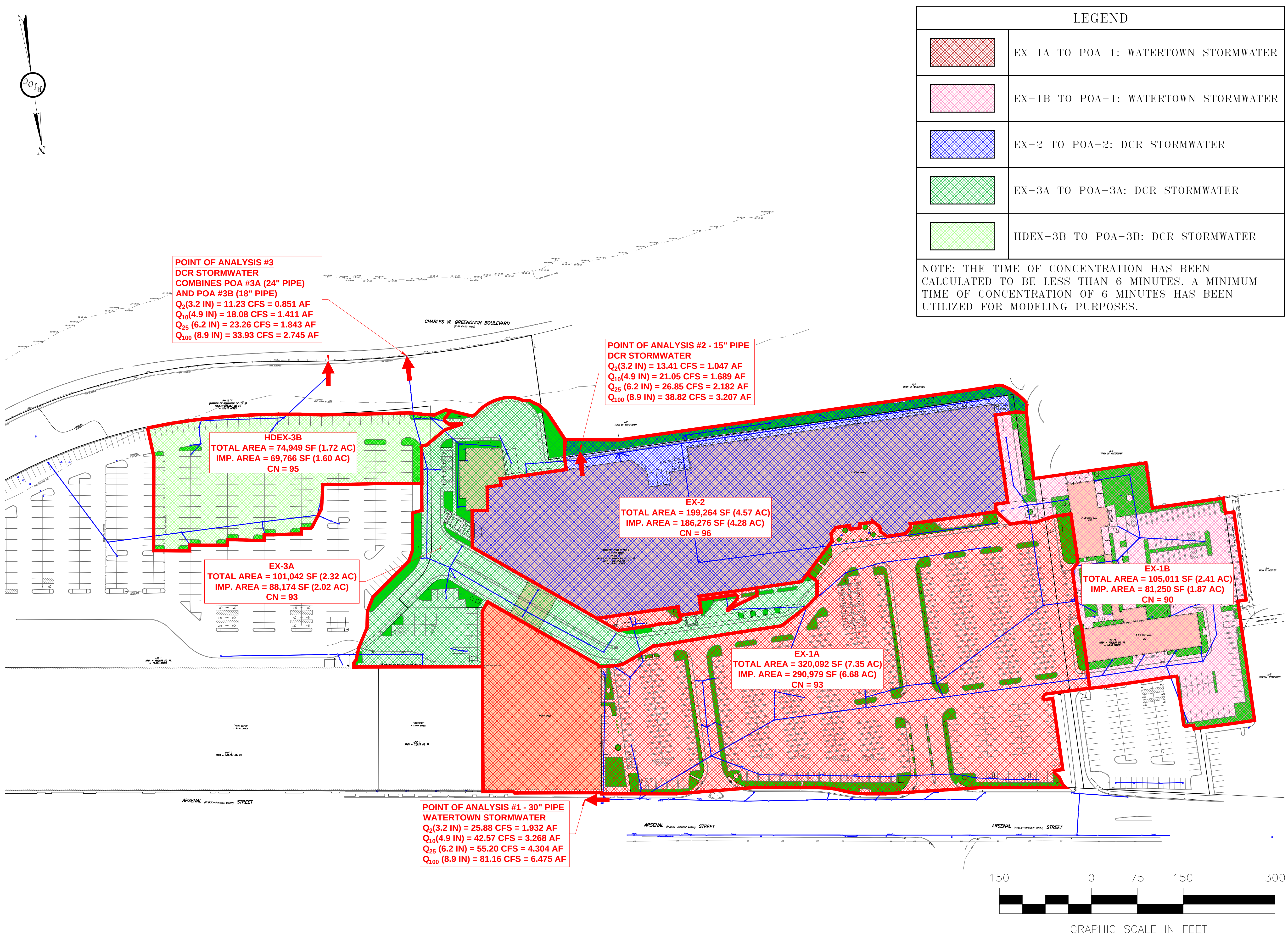
WELLHEAD PROTECTION MAP

Drawing No.:

FIG-5

Project No.: 16041

Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-5 Wellhead Protection Map.dwg
Jun 23, 2016 - 17:11pm



Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-6 Pre-Redevelopment Watersheds.dwg
Jun 23, 2016 - 17:13pm

No.	Revision	Date

Designed by:	JJS
Drawn by:	BMS
Checked by:	SPG/RWS
Scale:	1"=150'
Date:	07/11/2016

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Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

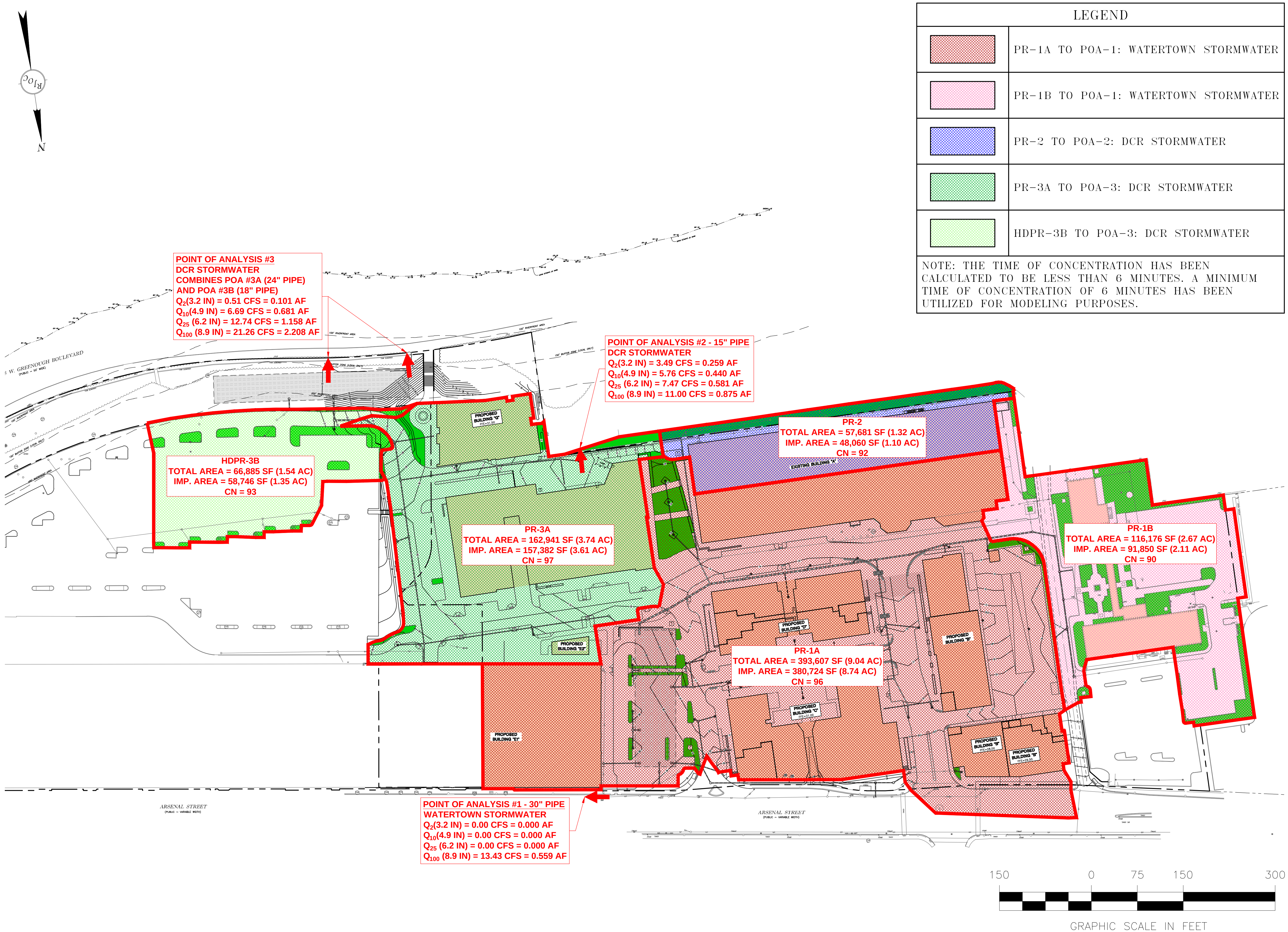
Drawing Name:

PRE-REDEVELOPMENT WATERSHED PLAN

Drawing No.:

FIG-6

Project No.: 16041



Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-7 Post-Redevelopment Watersheds.dwg
Jul 05, 2016 – 18:00pm

No.	Revision	Date

Designed by: JJS
Drawn by: BMS
Checked by: SPG/RWS
Scale: 1"=150'
Date: 07/11/2016

Prepared For:

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Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

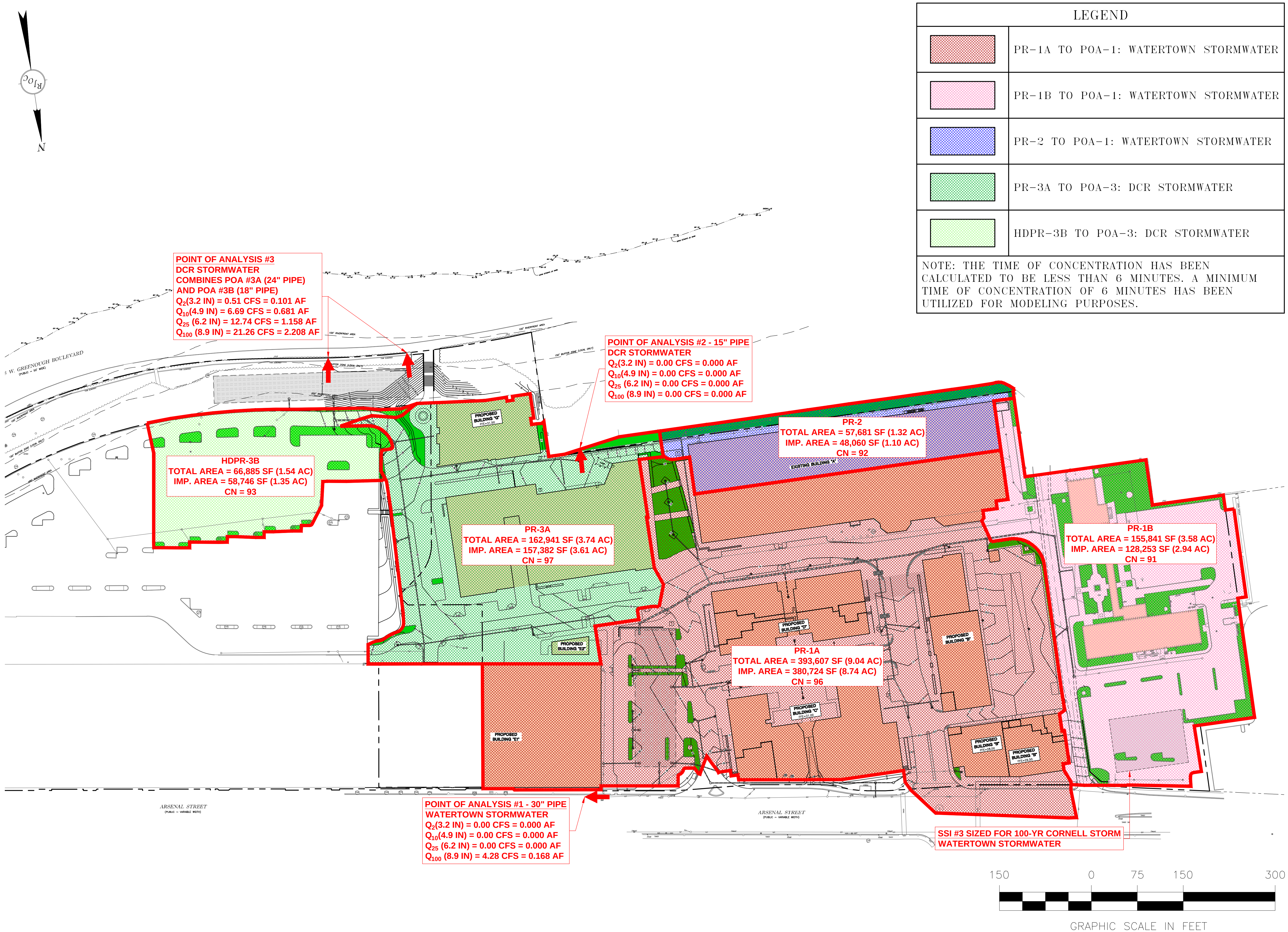
Drawing Name:

POST-REDEVELOPMENT WATERSHED PLAN

Drawing No.:

FIG-7

Project No.: 16041



LEGEND

	PR-1A TO POA-1: WATERTOWN STORMWATER
	PR-1B TO POA-1: WATERTOWN STORMWATER
	PR-2 TO POA-1: WATERTOWN STORMWATER
	PR-3A TO POA-3: DCR STORMWATER
	HDPR-3B TO POA-3: DCR STORMWATER

NOTE: THE TIME OF CONCENTRATION HAS BEEN CALCULATED TO BE LESS THAN 6 MINUTES. A MINIMUM TIME OF CONCENTRATION OF 6 MINUTES HAS BEEN UTILIZED FOR MODELING PURPOSES.

No.	Revision	Date

Designed by: JJS
Drawn by: BMS
Checked by: SPG/RWS
Scale: 1"=150'
Date: 07/11/2016

Prepared For:

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Project Name:

THE ARSENAL PROJECT
WATERTOWN, MA

Drawing Name:

FUTURE POST-REDEVELOPMENT WATERSHED PLAN

Drawing No.:

FIG-7A

Project No.: 16041

Drawing name: G:\MA\Watertown\Boylston Properties\Arsenal Mall\Reports\Stormwater Report\Figures\16041_FIG-7 Post-Redevelopment Watersheds.dwg Jul 05, 2016 – 18:06pm

III. APPENDIX A

MassDEP Checklist for Stormwater Report

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
JOHN J. STOY
CIVIL
No. 42797
REGISTERED PROFESSIONAL ENGINEER

J Stoy 7-11-16

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of “country drainage” versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): ______________________________

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☒ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:
- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

  ☐ is within the Zone II or Interim Wellhead Protection Area

  ☐ is near or to other critical areas

  ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

  ☒ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☐ The BMP is sized (and calculations provided) based on:

- ☐ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☒ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☒ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☒ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☐ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

III. APPENDIX B

Soils Information prepared by McPhail Associates, LLC

Memorandum

Date:	July 6, 2016
Recipient:	Boylston Properties Company, Inc. Jeffrey Heidelberg
Copy To:	RJ O'Connell & Associates, Inc. – Roy Smith
Sender:	Benjamin E. Downing, Jonathan W. Patch, P.E.
Project:	The Arsenal Project; Watertown, MA
Project No:	5573.2.02
Subject:	Rawls Infiltration Rate and Seasonal High Groundwater Levels for Stormwater Infiltration System Design

---

This memorandum documents our determination of the Rawls Infiltration Rates and seasonal high groundwater levels for use in the stormwater infiltration system design.

Based on the laboratory grain-size distributions of soil samples obtained from the borings and test pits, the soil texture class was determined using the USDA textural triangle. The soil texture class was then used to determine the Rawls Infiltration Rates. It is understood that the Rawls Infiltration Rates are based on research performed by Rawls, Brakensiek and Sexton in 1982 which used laboratory permeability testing to develop a relationship between texture class and saturated permeability.

Based on discussions with RJ O'Connell & Associates, Inc., the project site civil engineer, there are three (3) proposed areas for stormwater infiltration systems. The attached Table 1 contains information regarding the soil texture class and corresponding Rawls Infiltration Rate for each sample tested, and recommended Rawls Infiltration Rates for each of the proposed systems. Approximate subsurface exploration locations are shown on the attached figure.

Groundwater or indications of a seasonal high groundwater level were generally not observed in the test pits performed at the site. However, groundwater was encountered in the borings performed within the vicinity of the proposed infiltration systems and within the groundwater observation wells installed across the site. Based on the groundwater observation well and boring data, the ESHGW level for each of the proposed subsurface stormwater infiltration systems is contained in Table 1.

We trust that the above is sufficient for your present requirements. Should you have any questions concerning the recommendations presented herein, please do not hesitate to contact us

F:\WP5\JOBS\5573\Letters - Memos\5573_Rawls_Infiltration_Rate_Memo_070616.docx
Attachments: Table 1 – USDA Soil Classification Summary Table
Figure 2 – Subsurface Exploration Plan

GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERS
2269 Massachusetts Avenue
Cambridge, Massachusetts 02140
(617) 868-1420

Table 1
Summary of Recommended Rawls Infiltration Rates and ESHGW
The Arsenal Project
Job No. 5573

Subsurface Stormwater (SS) Infiltration System Location	Subsurface Exploration	Sample Elevation (ft)	Strata	USDA Soil Texture Class	Rawls Infiltration Rate (in/hr)	Recommended Rawls Infiltration Rate for System (in/hr)	Estimated Seasonal High Groundwater (ESHGW) Elevation (ft)
SS1	SS1-1	18.0	Alluvium	Sand	8.27	8.27	+8
	SS1-1	13.0	Alluvium	Sand	8.27		
	SS1-2	17.0	Alluvium	Sand	8.27		
	SS1-2	12.0	Alluvium	Sand	8.27		
	SS1-3	16.5	Alluvium	Sand	8.27		
	SS1-4	11.0	Alluvium	Sand	8.27		
SS2	SS2-1	11.6	Alluvium	Loamy Sand	2.41	1.02	+4
	SS2-1	9.6	Alluvium	Sand	8.27		
	SS2-2	6.5	Alluvium	Sand	8.27		
	SS2-3	8.0	Fill	Sandy Loam	1.02		
	SS2-4	8.0	Fill	Sandy Loam	1.02		
SS3	SS3-1	19.7	Fill	Loamy Sand	2.41	1.02	+7
	SS3-2	21.4	Alluvium	Sand	8.27		
	SS3-2	16.4	Alluvium	Sandy Loam	1.02		
	SS3-3	24.5	Fill	Loamy Sand	2.41		
	SS3-3	19.5	Fill	Loamy Sand	2.41		

LEGEND

— APPROXIMATE LOCATION OF TEST PIT PERFORMED BY F.E. FRENCH CONSTRUCTION, INC. FROM MAY 9 TO MAY 16, 2016 FOR McPHAIL ASSOCIATES, LLC

— APPROXIMATE LOCATION OF BORING PERFORMED BY CARR-DEE CORP. FROM MAY 3 TO MAY 13, 2016 FOR McPHAIL ASSOCIATES, LLC

— APPROXIMATE LOCATION OF BORING PERFORMED BY CARR-DEE CORP. FROM MAY 28 TO JUNE 4, 2013 FOR McPHAIL ASSOCIATES, LLC

(OW) — INDICATES OBSERVATION WELL INSTALLED WITHIN COMPLETED BOREHOLE

REFERENCE: THIS PLAN WAS PREPARED FROM A 20-SCALE DRAWING ENTITLED, "PARTIAL EXISTING CONDITIONS PLAN" DATED OCTOBER 16, 2014 PREPARED BY FELDMAN LAND SURVEYORS, A 40-SCALE DRAWING ENTITLED, "GROUND FLOOR, SCHEME 15-REFINED, THE ARSENAL PROJECT" DATED MARCH 23, 2016 PREPARED BY PCA, AND A 200-SCALE UNDATED DRAWING ENTITLED, "FIGURE 2, 1968 PROPERTY LAYOUT" BY ABB ENVIRONMENTAL SERVICES, INC.

GRAPHIC SCALE

50 0 50 100 200

FILE NAME: H:\Acad\JOBS\5573\GDR\5573-F02.dwg

McPHAIL ASSOCIATES, LLC
Geotechnical and Geoenvironmental Engineers
2269 Massachusetts Avenue
Cambridge, MA 02140
617/868-1420
617/868-1423 (Fax)
www.mcphailgeo.com

THE ARSENAL PROJECT

WATERTOWN MASSACHUSETTS

SUBSURFACE EXPLORATION PLAN

FOR

BOYLSTON PROPERTIES COMPANY, INC.

BY

McPHAIL ASSOCIATES, LLC

Date: JUNE 2016	Dwn: M.B.S.	Chkd: J.W.P.	Scale: 1" = 50'
Project No: 5573			FIGURE 2

III. APPENDIX C

Letter prepared by Linenthal Eisenberg Anderson, Inc. Engineers (LEA)

LEA

Established in 1922

Linenthal Eisenberg Anderson, Inc. Engineers

75 Kneeland Street, Boston, Massachusetts 02111 • (617) 426-6300

September 13, 1985

Arrowstreet, Inc.
14 Arrow Street
Cambridge, MA 02138

Attn: Ms. Susan Meyers

Re: Harvard Community Health Plan
Building 51 - Watertown Center
Arsenal Mall
Watertown, Massachusetts
LEA Project No. 85206.02

Dear Madam:

As requested, we have reviewed the present sanitary sewerage and storm drainage systems for the subject project to determine that the present systems can accommodate the proposed usage as required by Item 13 and 14 of the City of Watertown as part of their special permit decision 85-85-27.

Sanitary Sewer

The existing on-site sanitary sewer system consists of a new eight (8) inch P.V.C. line which was installed as part of the Arsenal Marketplace development. The sewer line from the proposed health center (Building 51) will be connected directly to a sewer manhole at the east end of Building 51. From this manhole, the 8-inch sewer runs easterly across the parking area to a manhole in the main entrance drive. This line has a capacity of 1.2 mgd at a velocity of 5.4 fps flowing full.

Figure-5

From the main entrance drive, the sewer runs northerly along the entrance drive to a manhole located at the westerly edge of Arsenal Street. The capacity of this 8-inch line is 1.1 mgd at 5.2 fps flowing full. From this manhole, the sewer line runs to an existing manhole located on the northerly side of Arsenal Street. The sewer line across Arsenal Street consists of an 8-inch ductile iron pipe with a capacity of 0.9 mgd at 4.0 fps flowing full. The existing manhole is located on the existing 15-inch sanitary sewer in Arsenal Street.

Storm Drainage

The new on-site storm drainage system was installed as part of the Arsenal Marketplace Mall development. Design of this system was based on a U.S. Weather Bureau Technical Paper No. 40 for a ten (10) year, 30 minute rainfall frequency and an initial fifteen (15) minute time of concentration. Based on this criteria, the total rainfall for design purposes is 4.18 inches. This basis appears to be consistent with the return frequency used for the original Watertown Arsenal and Arsenal Street storm drainage designs.

Runoff quantities have been calculated using the rational formula Q = C I A. Pipe sizes have been determined on this basis for full pipe flow using Manning's coefficient n = 0.013 for new concrete pipe. The Arsenal Marketplace Mall roof and parking areas tributary to the 30" drain in Elm Street, the parking areas tributary to new leaching basins with subsurface disposal of storm water, and parking areas tributary to leaching basins with a 12" perforated overflow pipe connected to the 30" new drain within the Arsenal Marketplace Mall site are tabulated as follows:

Surface	Tributary Area/Acres	Total Area/Acres	Volume C.F.S.	Percent of Total
Roof Areas	0.47			
	1.06			
	0.73			
		2.26	8.95	31.0
Parking Area tributary to new 30" NSC (excluding leaching basin areas)	5.31	5.31	19.93	69.0
		7.57	28.88	100.0
30" RCP capacity (Elm St.)			35.00	
Arsenal Street			6.12	
Parking area tributary to new leaching basins with overflow to 30" NSD	0.61			
	0.76			
		1.37	5.12	
Parking area tributary to new leaching basins without overflow to new 30" NSD	0.96			
	0.34			
	0.06			
		1.36	5.10	

The original design calculations included 21.3 acres of the parking area directly tributary to the new 30" drain via a closed system of catch basins and solid piping. During design of the Arsenal Marketplace Mall, a design change reduced this area by 1.37 acres through subsurface recharge via the use of perforated precast concrete leaching basins interconnected with 12" perforated V.C. pipe laid level, and surrounded by a stone filter material.

As can be seen from our tabulation, the roof areas represent 31.0 percent (2.26 acres) of the total on-site acre tributary to the 30" NSD in Elm Street (excluding on-site leaching basin areas and Arsenal Street). The Watertown Department of Public Works required that we intercept the existing 12" drain in Arsenal Street at the Elm Street intersection and connect it to the new 30" drain from the Arsenal Marketplace. This was done to relieve flooding problems at the intersection of Arsenal, Arlington and Coolidge Streets. The capacity which has been provided in the 30" R.C.P. to serve Arsenal Street is 6.12 C.F.S.; in excess of the C.F.S. capacity (approximate) of the existing 12" Arsenal Street drain.

New catch basins have been constructed along the south side of Arsenal Street (under the Town of Watertown/Massachusetts DPW Arsenal Street Reconstruction Project) in the vicinity of the new 30" storm drain and have been connected to the new drain.

The areas of building roof, pavement, landscaping, and runoff characteristics are essentially the same for the proposed health facility as the basis used for the original design of the new storm drainage system. The new storm drainage system drains the westerly portion of the Arsenal Mall site adjacent to Arsenal Street and discharges through a separate 30-inch outfall drain down Elm Street to the existing Elm Street culvert.

On the basis of the original design for the Arsenal Mall sanitary sewerage and storm drainage systems and the proposed use of Building 51 and its new addition for the Harvard Community Health Plan, there is adequate capacity for the existing and proposed uses on the site.

Please call me directly with any questions.

Very truly yours,

LINENTHAL EISENBERG ANDERSON, INC.

Arthur J. Towne

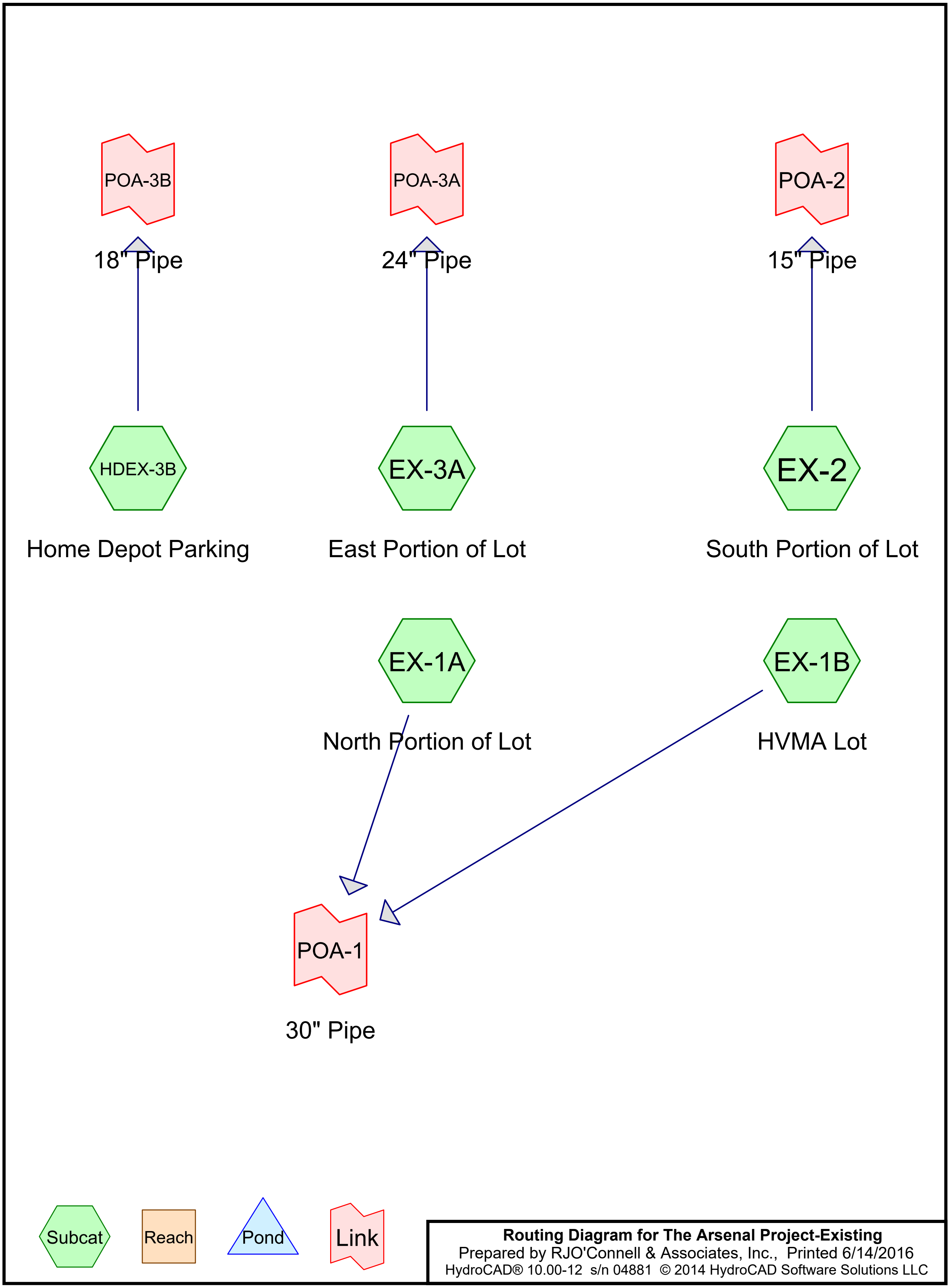
Arthur J. Towne
Project Manager

AJT/dd/D10

IV. APPENDIX D

Computations

Pre-Redevelopment Hydrological Computations



Routing Diagram for The Arsenal Project-Existing
Prepared by RJO'Connell & Associates, Inc., Printed 6/14/2016
HydroCAD® 10.00-12 s/n 04881 © 2014 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1A: North Portion of Lot Runoff Area=320,092 sf 90.90% Impervious Runoff Depth>2.44"
Tc=6.0 min CN=93 Runoff=19.94 cfs 1.497 af

Subcatchment EX-1B: HVMA Lot Runoff Area=105,011 sf 77.37% Impervious Runoff Depth>2.17"
Tc=6.0 min CN=90 Runoff=5.93 cfs 0.435 af

Subcatchment EX-2: South Portion of Lot Runoff Area=199,264 sf 93.48% Impervious Runoff Depth>2.75"
Tc=6.0 min CN=96 Runoff=13.41 cfs 1.047 af

Subcatchment EX-3A: East Portion of Lot Runoff Area=101,042 sf 87.26% Impervious Runoff Depth>2.44"
Tc=6.0 min CN=93 Runoff=6.30 cfs 0.472 af

Subcatchment HDEX-3B: Home Depot Runoff Area=74,949 sf 93.08% Impervious Runoff Depth>2.64"
Tc=6.0 min CN=95 Runoff=4.93 cfs 0.379 af

Link POA-1: 30" Pipe Inflow=25.88 cfs 1.932 af
Primary=25.88 cfs 1.932 af

Link POA-2: 15" Pipe Inflow=13.41 cfs 1.047 af
Primary=13.41 cfs 1.047 af

Link POA-3A: 24" Pipe Inflow=6.30 cfs 0.472 af
Primary=6.30 cfs 0.472 af

Link POA-3B: 18" Pipe Inflow=4.93 cfs 0.379 af
Primary=4.93 cfs 0.379 af

Total Runoff Area = 18.374 ac Runoff Volume = 3.831 af Average Runoff Depth = 2.50"
10.48% Pervious = 1.926 ac 89.52% Impervious = 16.447 ac

Summary for Subcatchment EX-1A: North Portion of Lot

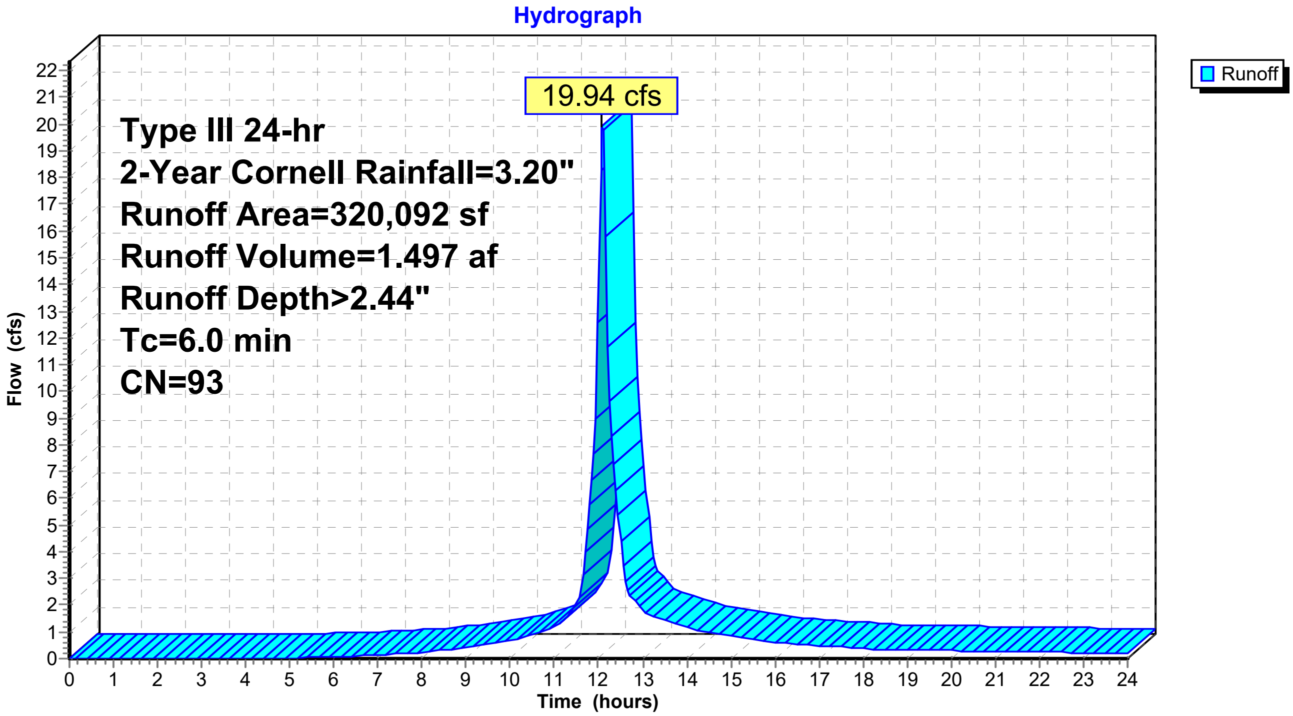
Runoff = 19.94 cfs @ 12.09 hrs, Volume= 1.497 af, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
29,113	39	>75% Grass cover, Good, HSG A
49,302	98	Roofs, HSG A
241,677	98	Paved parking, HSG A
320,092	93	Weighted Average
29,113		9.10% Pervious Area
290,979		90.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1A: North Portion of Lot



Summary for Subcatchment EX-1B: HVMA Lot

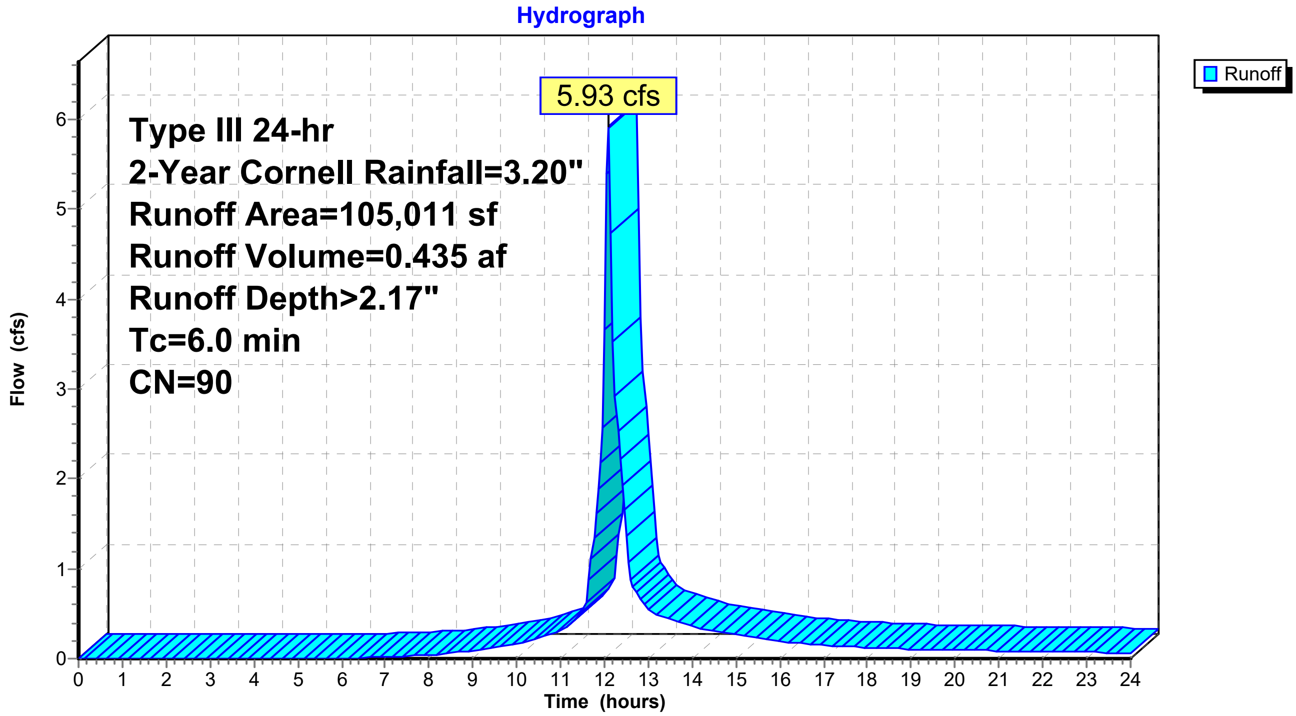
Runoff = 5.93 cfs @ 12.09 hrs, Volume= 0.435 af, Depth> 2.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
23,761	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
62,625	98	Paved parking, HSG B
105,011	90	Weighted Average
23,761		22.63% Pervious Area
81,250		77.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1B: HVMA Lot



Summary for Subcatchment EX-2: South Portion of Lot

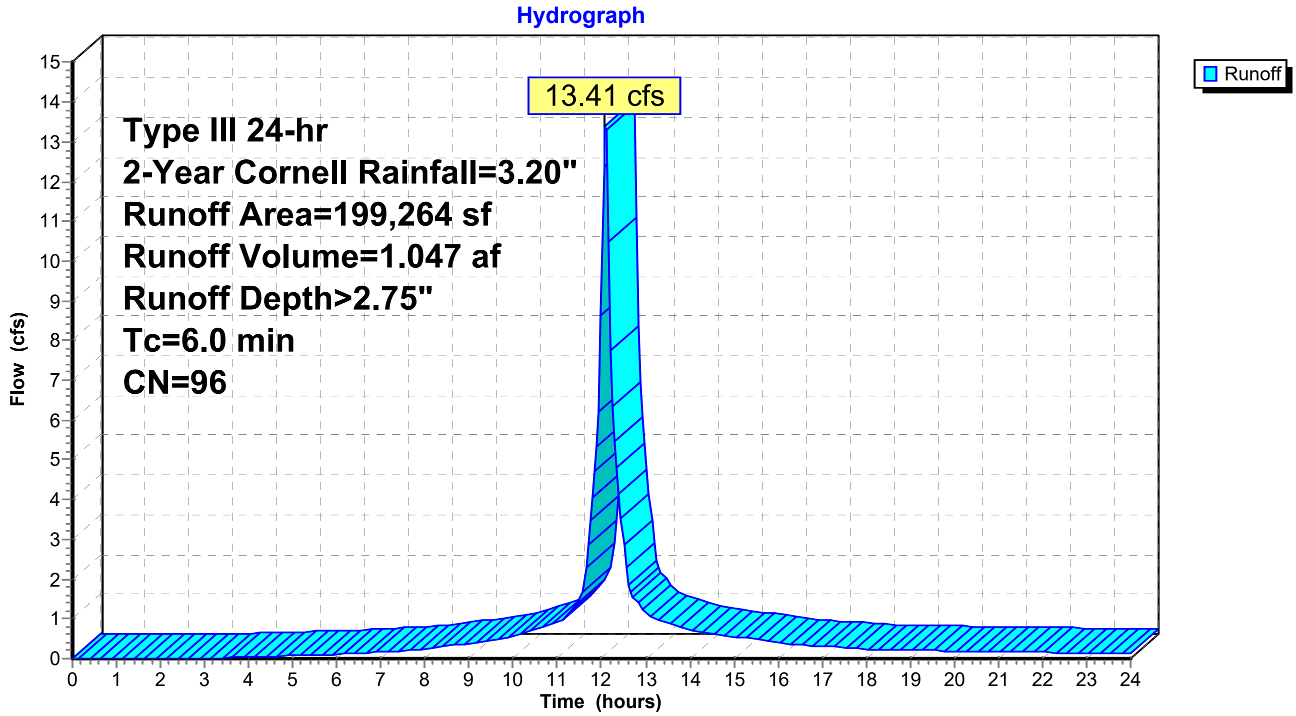
Runoff = 13.41 cfs @ 12.09 hrs, Volume= 1.047 af, Depth> 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
12,988	61	>75% Grass cover, Good, HSG B
172,371	98	Roofs, HSG B
13,905	98	Paved parking, HSG B
199,264	96	Weighted Average
12,988		6.52% Pervious Area
186,276		93.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-2: South Portion of Lot



Summary for Subcatchment EX-3A: East Portion of Lot

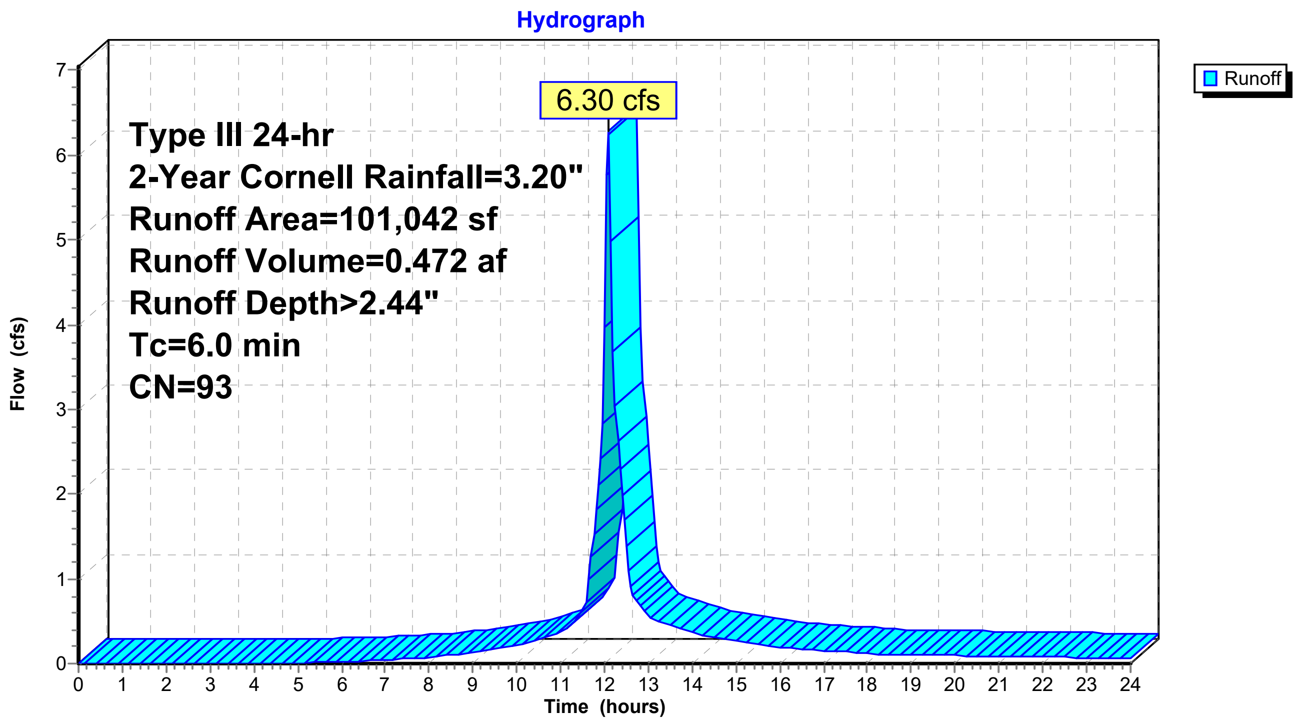
Runoff = 6.30 cfs @ 12.09 hrs, Volume= 0.472 af, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
12,868	61	>75% Grass cover, Good, HSG B
9,302	98	Roofs, HSG B
78,872	98	Paved parking, HSG B
101,042	93	Weighted Average
12,868		12.74% Pervious Area
88,174		87.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-3A: East Portion of Lot



Summary for Subcatchment HDEX-3B: Home Depot Parking

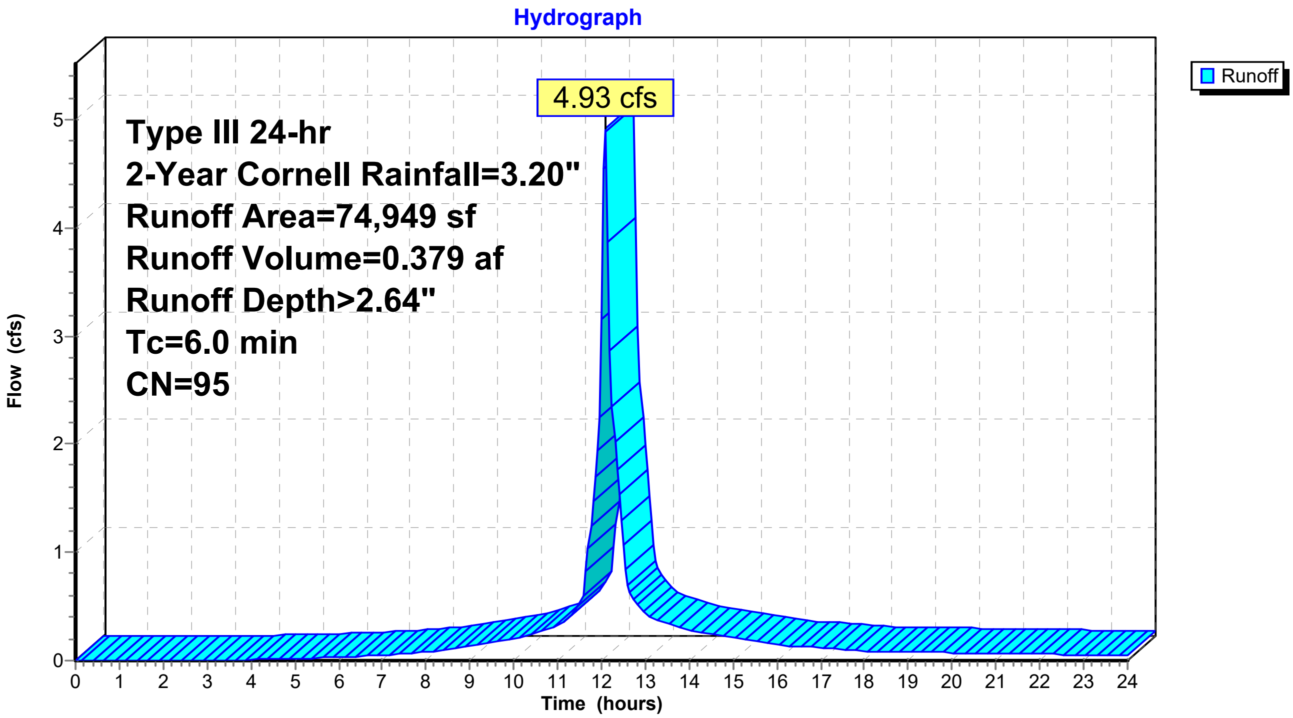
Runoff = 4.93 cfs @ 12.09 hrs, Volume= 0.379 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
5,183	61	>75% Grass cover, Good, HSG B
69,766	98	Paved parking, HSG B
74,949	95	Weighted Average
5,183		6.92% Pervious Area
69,766		93.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDEX-3B: Home Depot Parking

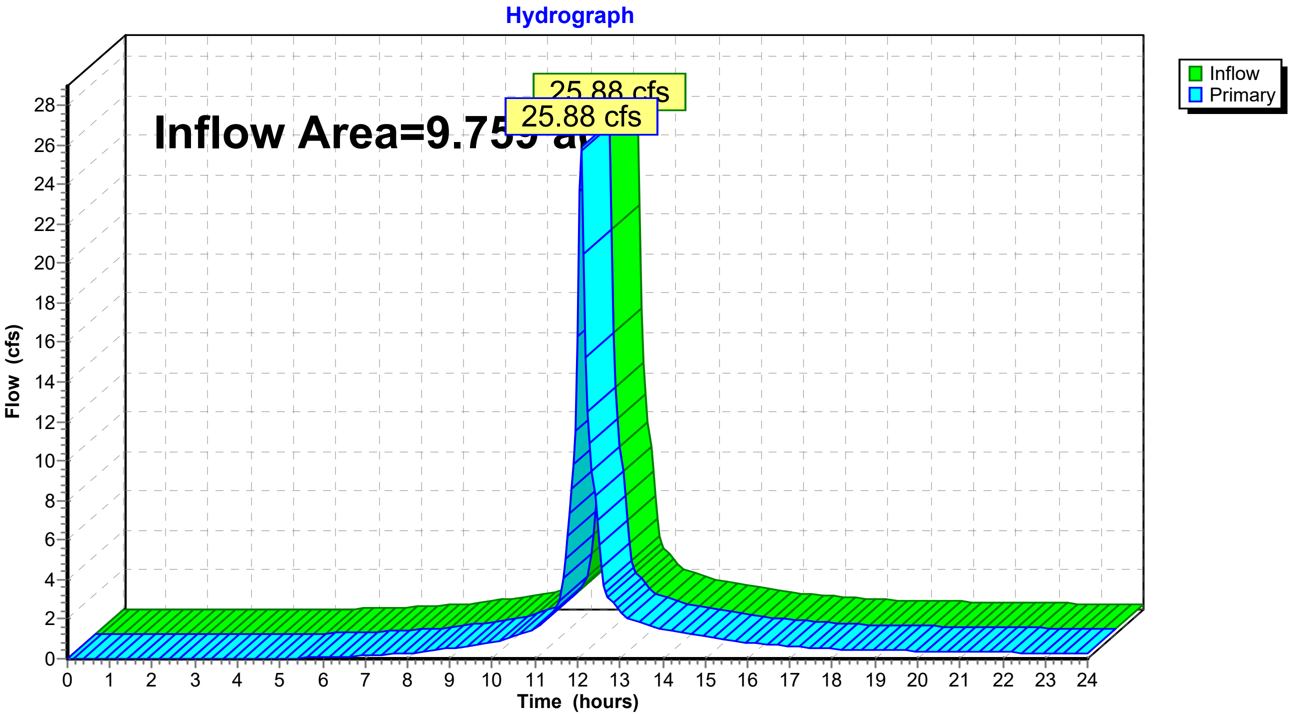


Summary for Link POA-1: 30" Pipe

Inflow Area = 9.759 ac, 87.56% Impervious, Inflow Depth > 2.38" for 2-Year Cornell event
Inflow = 25.88 cfs @ 12.09 hrs, Volume= 1.932 af
Primary = 25.88 cfs @ 12.09 hrs, Volume= 1.932 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

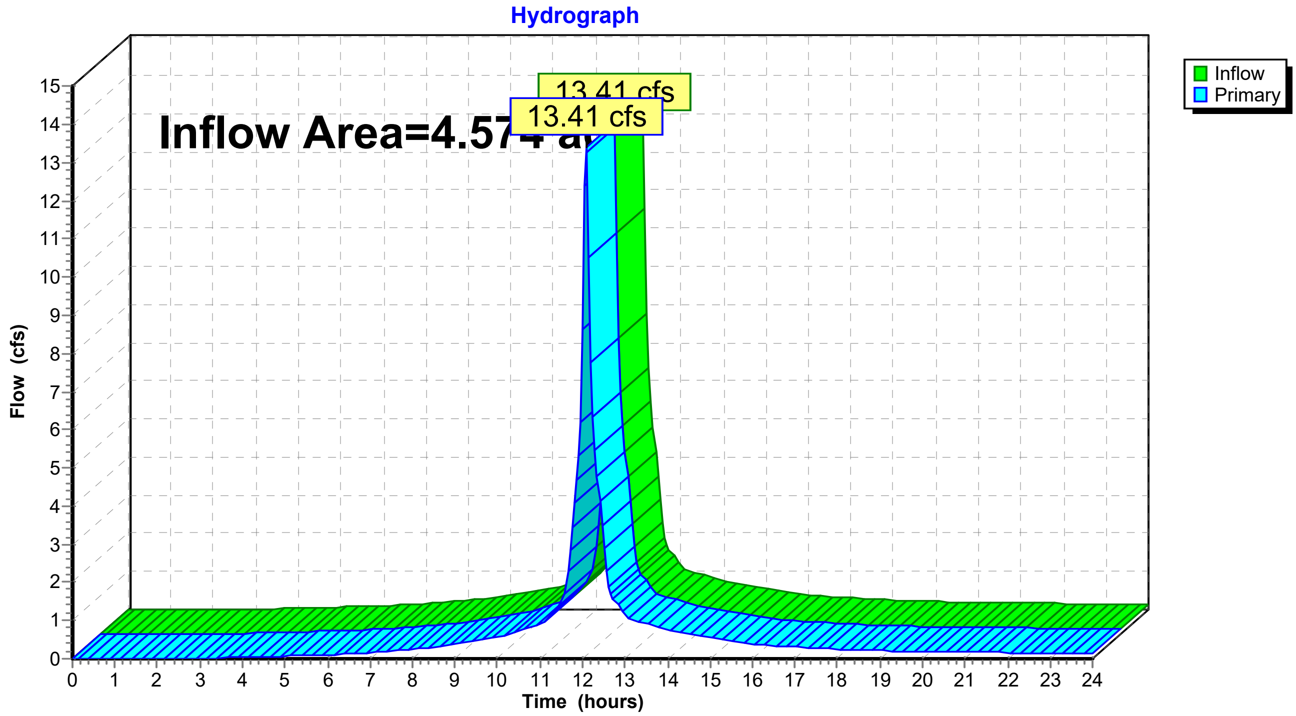


Summary for Link POA-2: 15" Pipe

Inflow Area =	4.574 ac,	93.48% Impervious,	Inflow Depth > 2.75"	for 2-Year Cornell event	
Inflow =	13.41 cfs @	12.09 hrs,	Volume=	1.047 af	
Primary =	13.41 cfs @	12.09 hrs,	Volume=	1.047 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

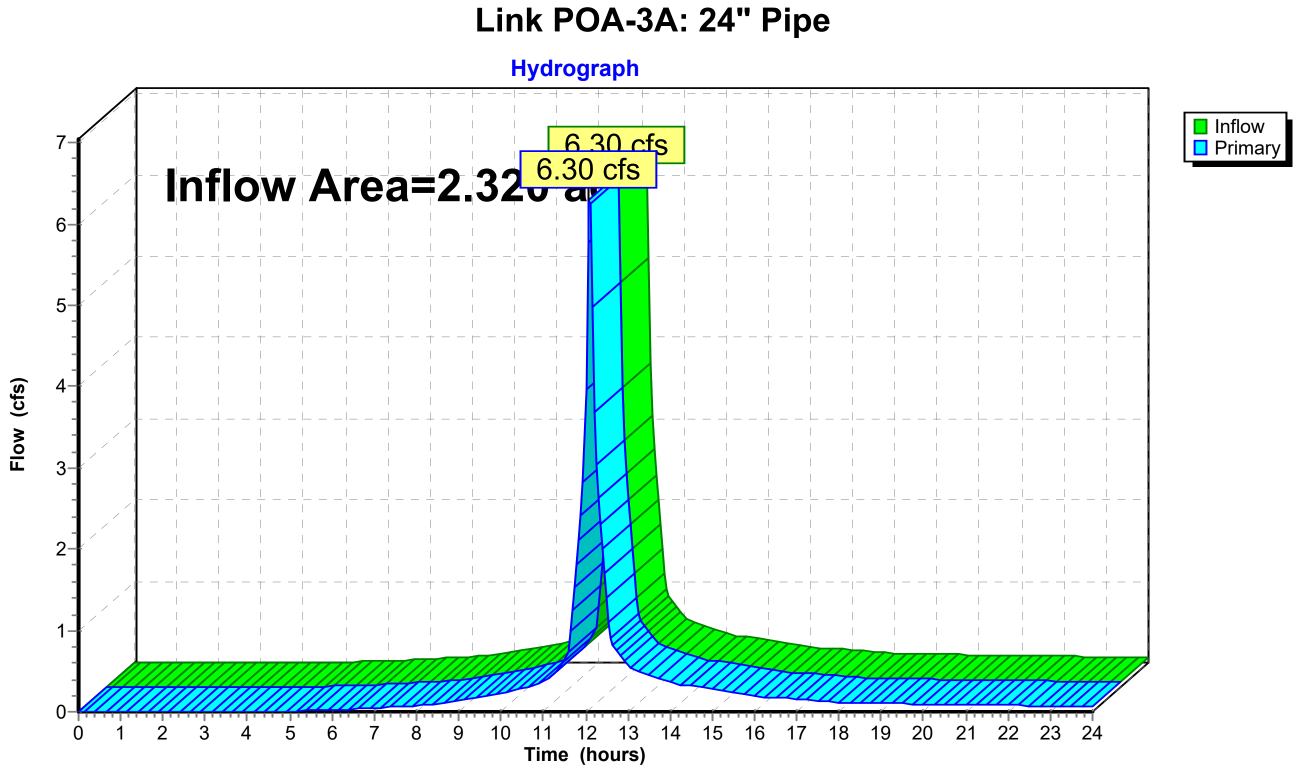
Link POA-2: 15" Pipe



Summary for Link POA-3A: 24" Pipe

Inflow Area = 2.320 ac, 87.26% Impervious, Inflow Depth > 2.44" for 2-Year Cornell event
Inflow = 6.30 cfs @ 12.09 hrs, Volume= 0.472 af
Primary = 6.30 cfs @ 12.09 hrs, Volume= 0.472 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

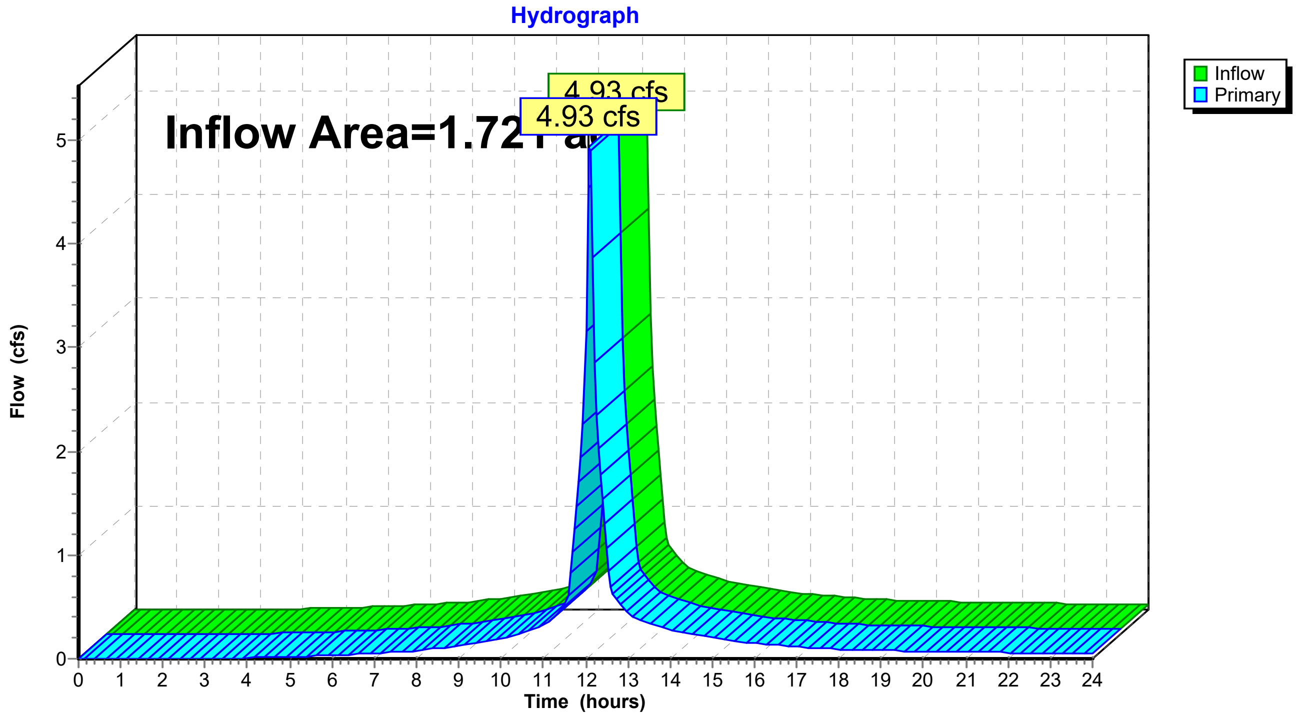


Summary for Link POA-3B: 18" Pipe

Inflow Area =	1.721 ac,	93.08% Impervious,	Inflow Depth > 2.64"	for 2-Year Cornell event
Inflow =	4.93 cfs @	12.09 hrs, Volume=	0.379 af	
Primary =	4.93 cfs @	12.09 hrs, Volume=	0.379 af, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3B: 18" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1A: North Portion of Lot Runoff Area=320,092 sf 90.90% Impervious Runoff Depth>4.10"
Tc=6.0 min CN=93 Runoff=32.48 cfs 2.509 af

Subcatchment EX-1B: HVMA Lot Runoff Area=105,011 sf 77.37% Impervious Runoff Depth>3.78"
Tc=6.0 min CN=90 Runoff=10.09 cfs 0.759 af

Subcatchment EX-2: South Portion of Lot Runoff Area=199,264 sf 93.48% Impervious Runoff Depth>4.43"
Tc=6.0 min CN=96 Runoff=21.05 cfs 1.689 af

Subcatchment EX-3A: East Portion of Lot Runoff Area=101,042 sf 87.26% Impervious Runoff Depth>4.10"
Tc=6.0 min CN=93 Runoff=10.25 cfs 0.792 af

Subcatchment HDEX-3B: Home Depot Runoff Area=74,949 sf 93.08% Impervious Runoff Depth>4.32"
Tc=6.0 min CN=95 Runoff=7.83 cfs 0.619 af

Link POA-1: 30" Pipe Inflow=42.57 cfs 3.268 af
Primary=42.57 cfs 3.268 af

Link POA-2: 15" Pipe Inflow=21.05 cfs 1.689 af
Primary=21.05 cfs 1.689 af

Link POA-3A: 24" Pipe Inflow=10.25 cfs 0.792 af
Primary=10.25 cfs 0.792 af

Link POA-3B: 18" Pipe Inflow=7.83 cfs 0.619 af
Primary=7.83 cfs 0.619 af

Total Runoff Area = 18.374 ac Runoff Volume = 6.368 af Average Runoff Depth = 4.16"
10.48% Pervious = 1.926 ac 89.52% Impervious = 16.447 ac

Summary for Subcatchment EX-1A: North Portion of Lot

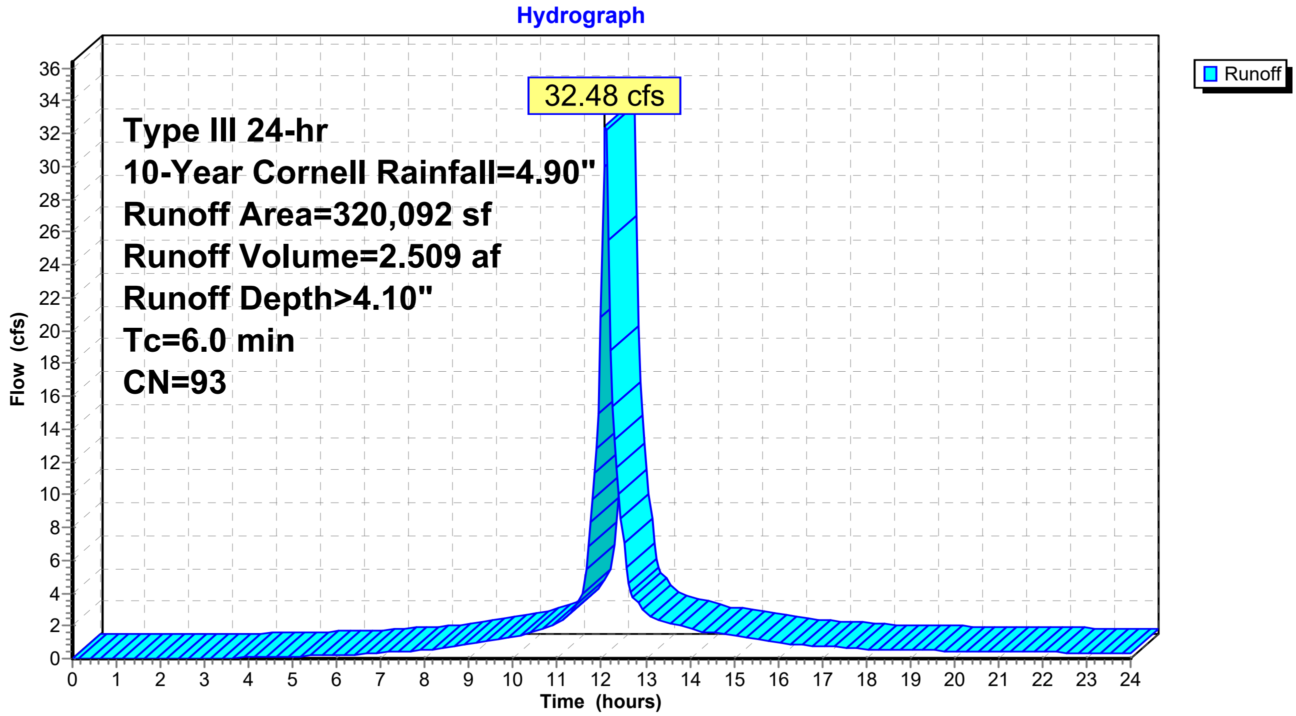
Runoff = 32.48 cfs @ 12.09 hrs, Volume= 2.509 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
29,113	39	>75% Grass cover, Good, HSG A
49,302	98	Roofs, HSG A
241,677	98	Paved parking, HSG A
320,092	93	Weighted Average
29,113		9.10% Pervious Area
290,979		90.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1A: North Portion of Lot



Summary for Subcatchment EX-1B: HVMA Lot

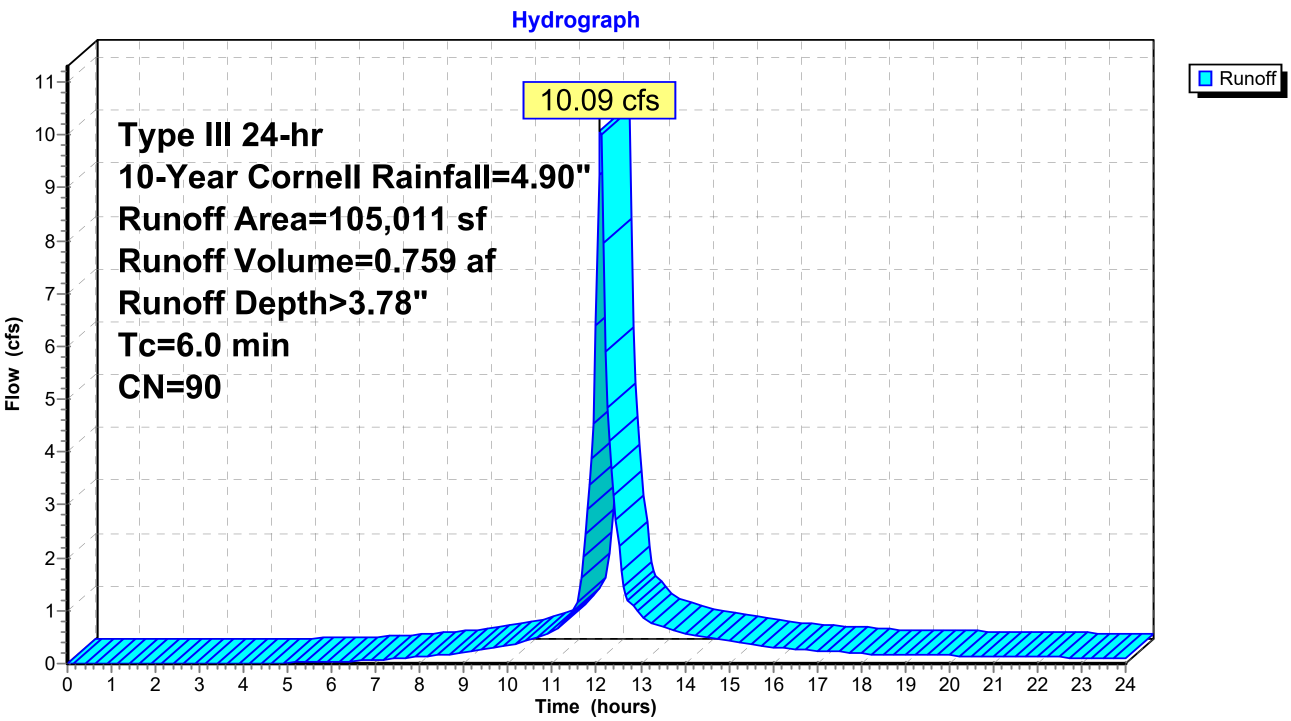
Runoff = 10.09 cfs @ 12.09 hrs, Volume= 0.759 af, Depth> 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
23,761	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
62,625	98	Paved parking, HSG B
105,011	90	Weighted Average
23,761		22.63% Pervious Area
81,250		77.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1B: HVMA Lot



Summary for Subcatchment EX-2: South Portion of Lot

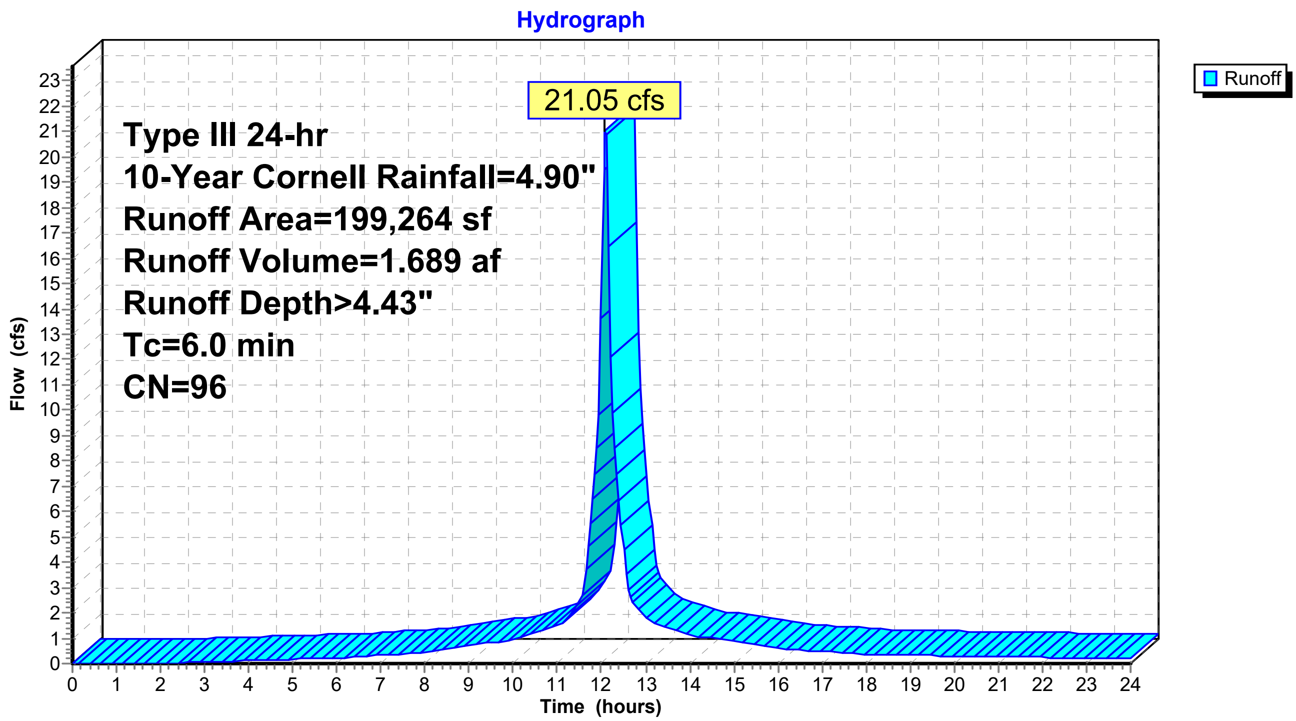
Runoff = 21.05 cfs @ 12.09 hrs, Volume= 1.689 af, Depth> 4.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
12,988	61	>75% Grass cover, Good, HSG B
172,371	98	Roofs, HSG B
13,905	98	Paved parking, HSG B
199,264	96	Weighted Average
12,988		6.52% Pervious Area
186,276		93.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-2: South Portion of Lot



Summary for Subcatchment EX-3A: East Portion of Lot

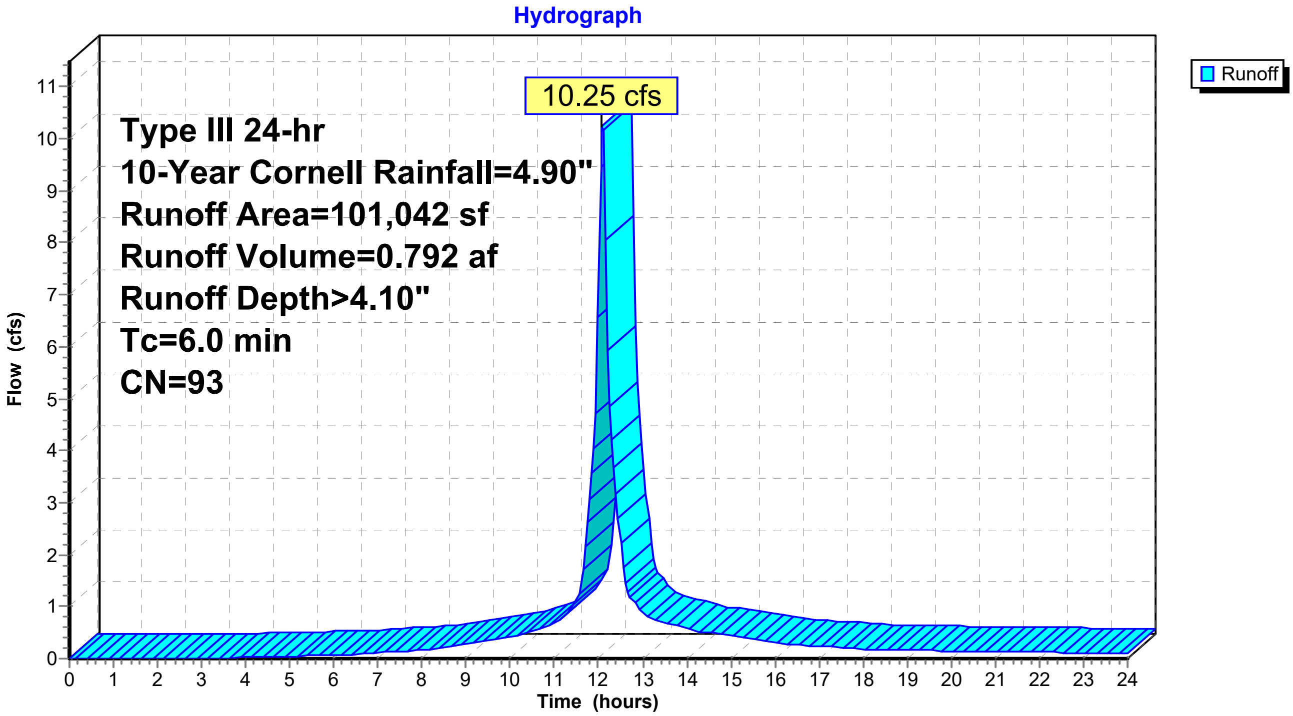
Runoff = 10.25 cfs @ 12.09 hrs, Volume= 0.792 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
12,868	61	>75% Grass cover, Good, HSG B
9,302	98	Roofs, HSG B
78,872	98	Paved parking, HSG B
101,042	93	Weighted Average
12,868		12.74% Pervious Area
88,174		87.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-3A: East Portion of Lot



Summary for Subcatchment HDEX-3B: Home Depot Parking

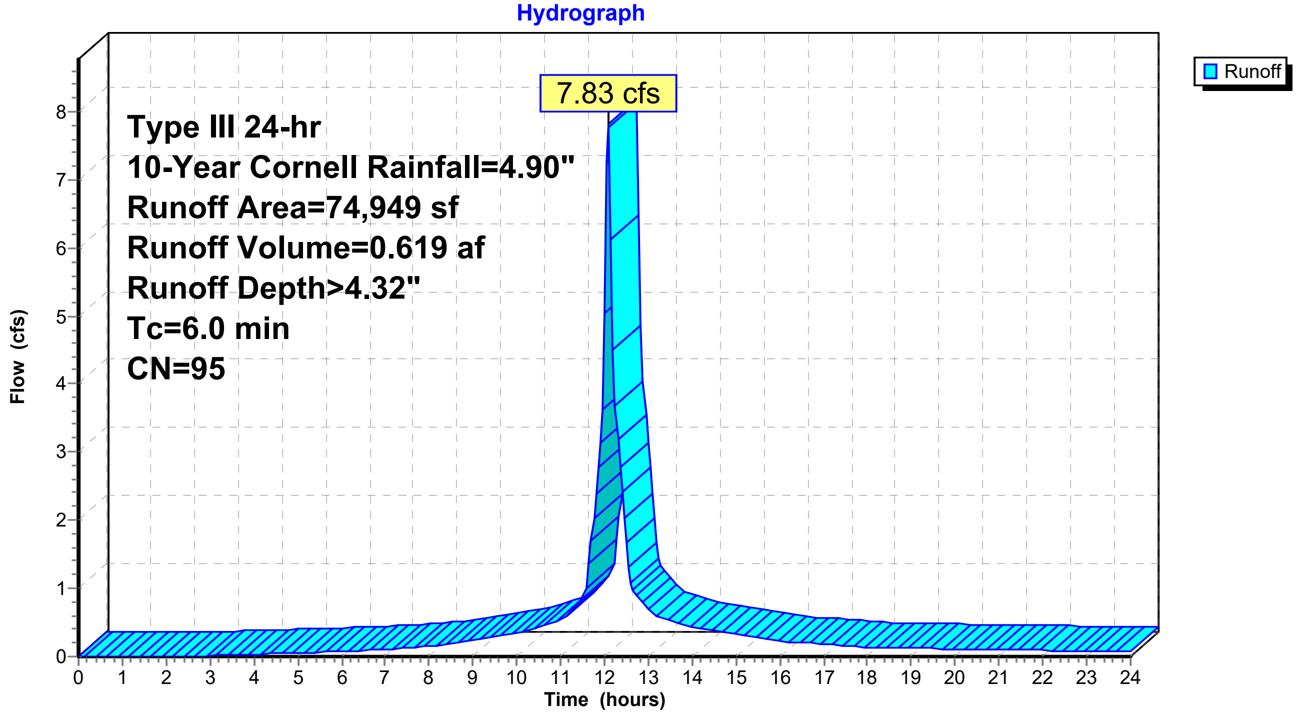
Runoff = 7.83 cfs @ 12.09 hrs, Volume= 0.619 af, Depth> 4.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
5,183	61	>75% Grass cover, Good, HSG B
69,766	98	Paved parking, HSG B
74,949	95	Weighted Average
5,183		6.92% Pervious Area
69,766		93.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDEX-3B: Home Depot Parking

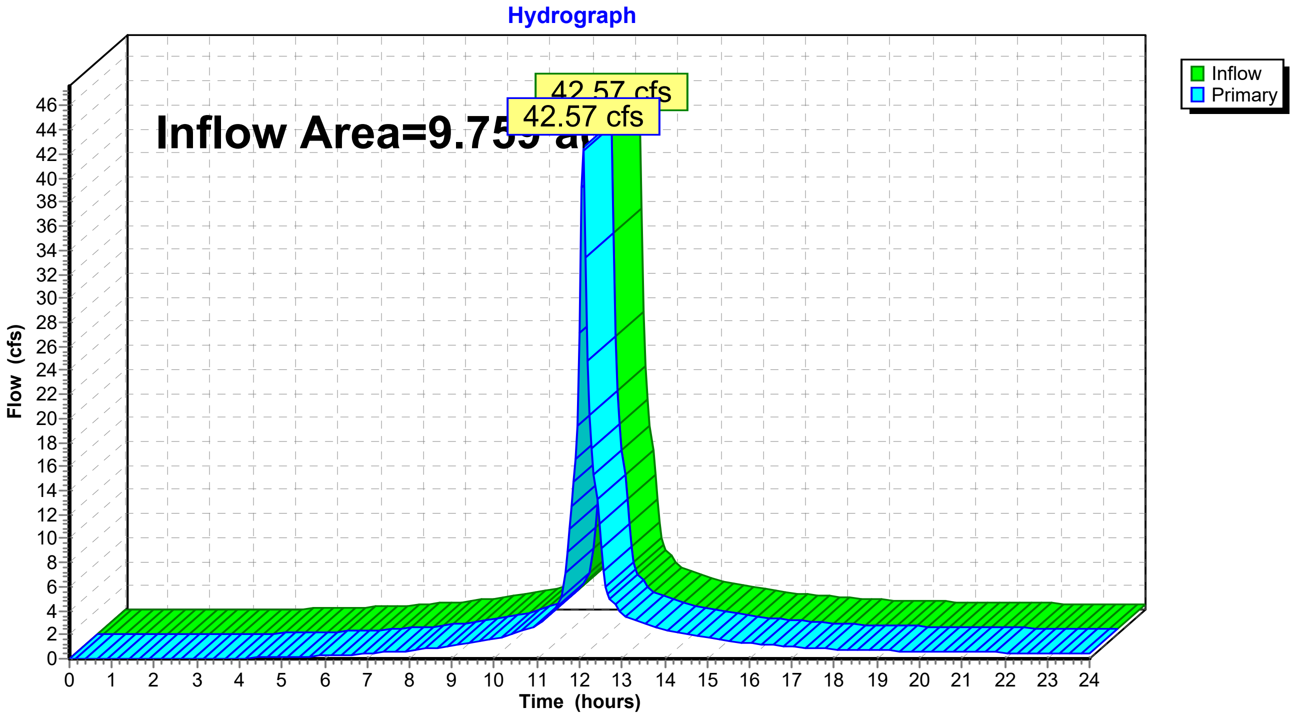


Summary for Link POA-1: 30" Pipe

Inflow Area = 9.759 ac, 87.56% Impervious, Inflow Depth > 4.02" for 10-Year Cornell event
Inflow = 42.57 cfs @ 12.09 hrs, Volume= 3.268 af
Primary = 42.57 cfs @ 12.09 hrs, Volume= 3.268 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

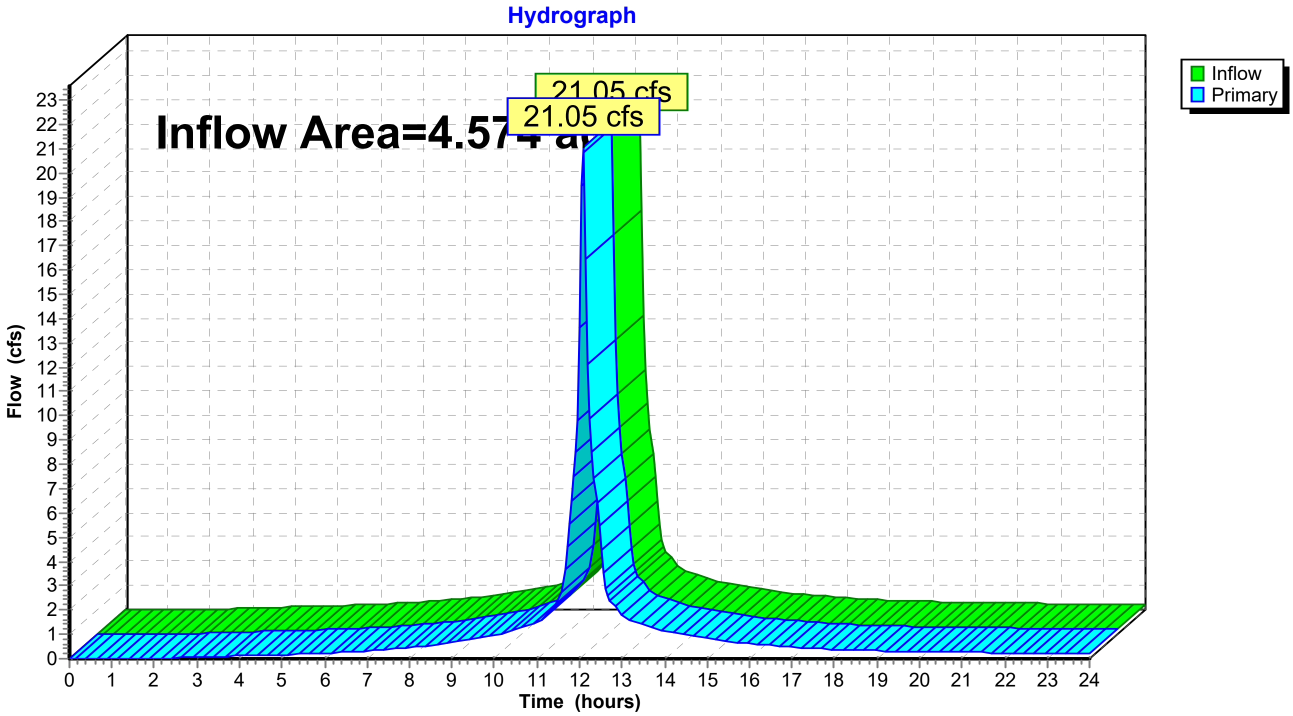


Summary for Link POA-2: 15" Pipe

Inflow Area = 4.574 ac, 93.48% Impervious, Inflow Depth > 4.43" for 10-Year Cornell event
Inflow = 21.05 cfs @ 12.09 hrs, Volume= 1.689 af
Primary = 21.05 cfs @ 12.09 hrs, Volume= 1.689 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

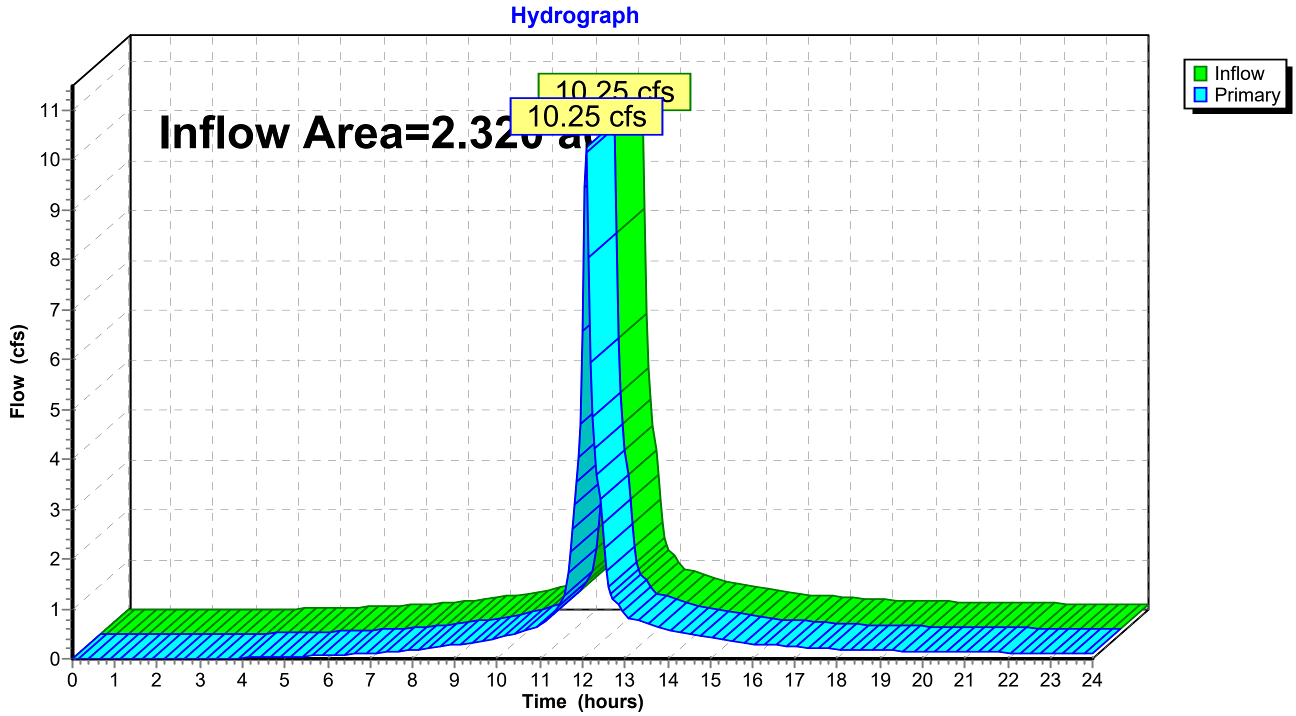


Summary for Link POA-3A: 24" Pipe

Inflow Area = 2.320 ac, 87.26% Impervious, Inflow Depth > 4.10" for 10-Year Cornell event
Inflow = 10.25 cfs @ 12.09 hrs, Volume= 0.792 af
Primary = 10.25 cfs @ 12.09 hrs, Volume= 0.792 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3A: 24" Pipe

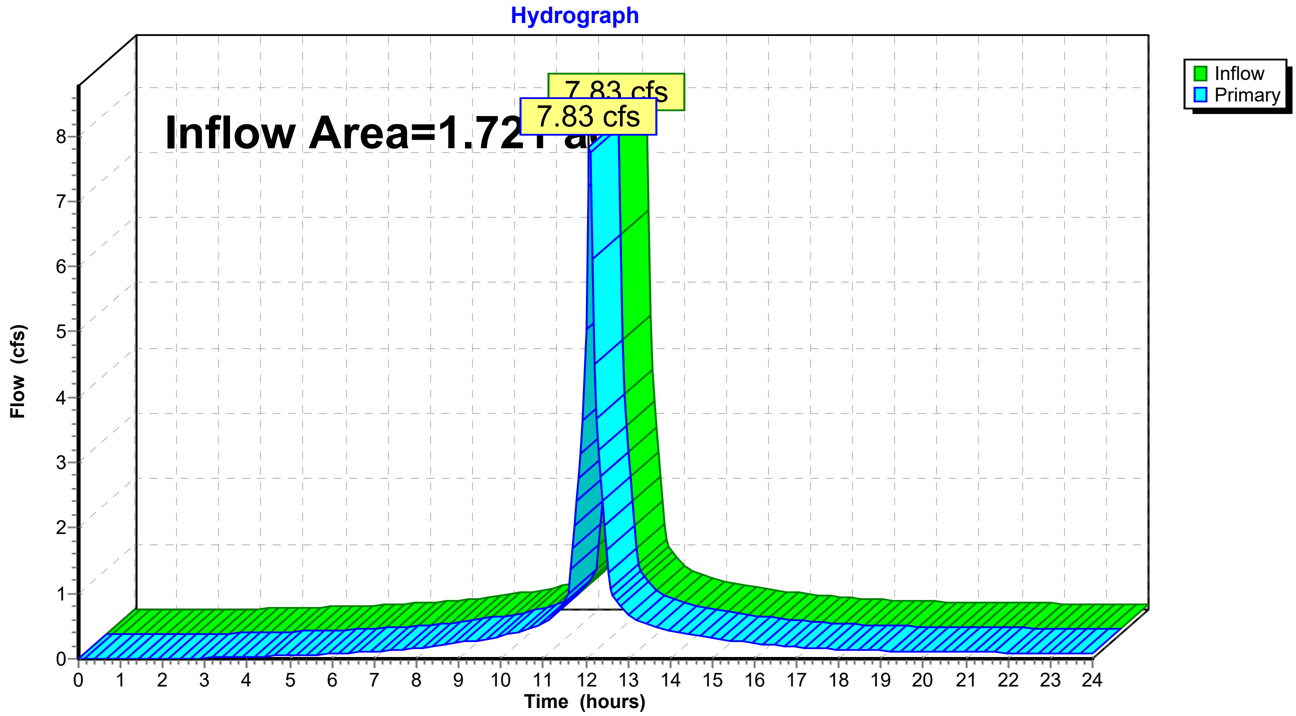


Summary for Link POA-3B: 18" Pipe

Inflow Area = 1.721 ac, 93.08% Impervious, Inflow Depth > 4.32" for 10-Year Cornell event
Inflow = 7.83 cfs @ 12.09 hrs, Volume= 0.619 af
Primary = 7.83 cfs @ 12.09 hrs, Volume= 0.619 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3B: 18" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1A: North Portion of Lot Runoff Area=320,092 sf 90.90% Impervious Runoff Depth>5.38"
Tc=6.0 min CN=93 Runoff=41.96 cfs 3.292 af

Subcatchment EX-1B: HVMA Lot Runoff Area=105,011 sf 77.37% Impervious Runoff Depth>5.04"
Tc=6.0 min CN=90 Runoff=13.24 cfs 1.012 af

Subcatchment EX-2: South Portion of Lot Runoff Area=199,264 sf 93.48% Impervious Runoff Depth>5.72"
Tc=6.0 min CN=96 Runoff=26.85 cfs 2.182 af

Subcatchment EX-3A: East Portion of Lot Runoff Area=101,042 sf 87.26% Impervious Runoff Depth>5.38"
Tc=6.0 min CN=93 Runoff=13.24 cfs 1.039 af

Subcatchment HDEX-3B: Home Depot Runoff Area=74,949 sf 93.08% Impervious Runoff Depth>5.61"
Tc=6.0 min CN=95 Runoff=10.02 cfs 0.804 af

Link POA-1: 30" Pipe Inflow=55.20 cfs 4.304 af
Primary=55.20 cfs 4.304 af

Link POA-2: 15" Pipe Inflow=26.85 cfs 2.182 af
Primary=26.85 cfs 2.182 af

Link POA-3A: 24" Pipe Inflow=13.24 cfs 1.039 af
Primary=13.24 cfs 1.039 af

Link POA-3B: 18" Pipe Inflow=10.02 cfs 0.804 af
Primary=10.02 cfs 0.804 af

Total Runoff Area = 18.374 ac Runoff Volume = 8.329 af Average Runoff Depth = 5.44"
10.48% Pervious = 1.926 ac 89.52% Impervious = 16.447 ac

Summary for Subcatchment EX-1A: North Portion of Lot

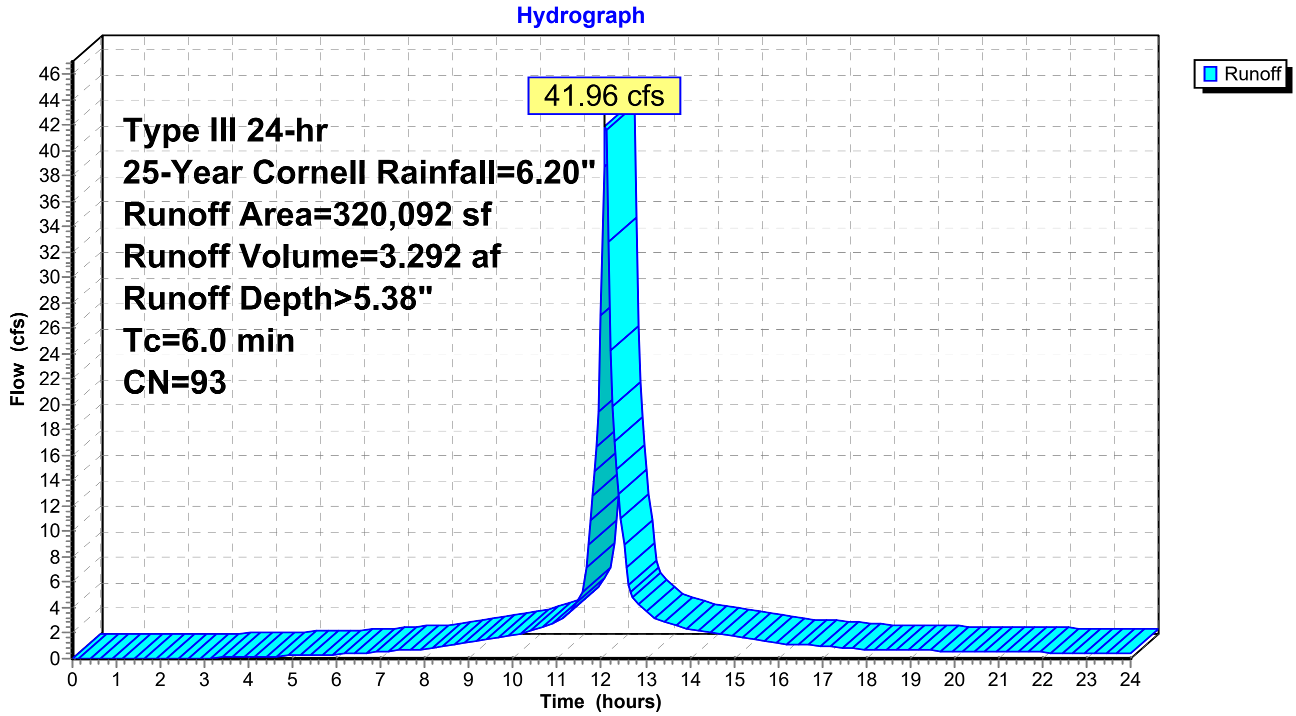
Runoff = 41.96 cfs @ 12.09 hrs, Volume= 3.292 af, Depth> 5.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
29,113	39	>75% Grass cover, Good, HSG A
49,302	98	Roofs, HSG A
241,677	98	Paved parking, HSG A
320,092	93	Weighted Average
29,113		9.10% Pervious Area
290,979		90.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1A: North Portion of Lot



Summary for Subcatchment EX-1B: HVMA Lot

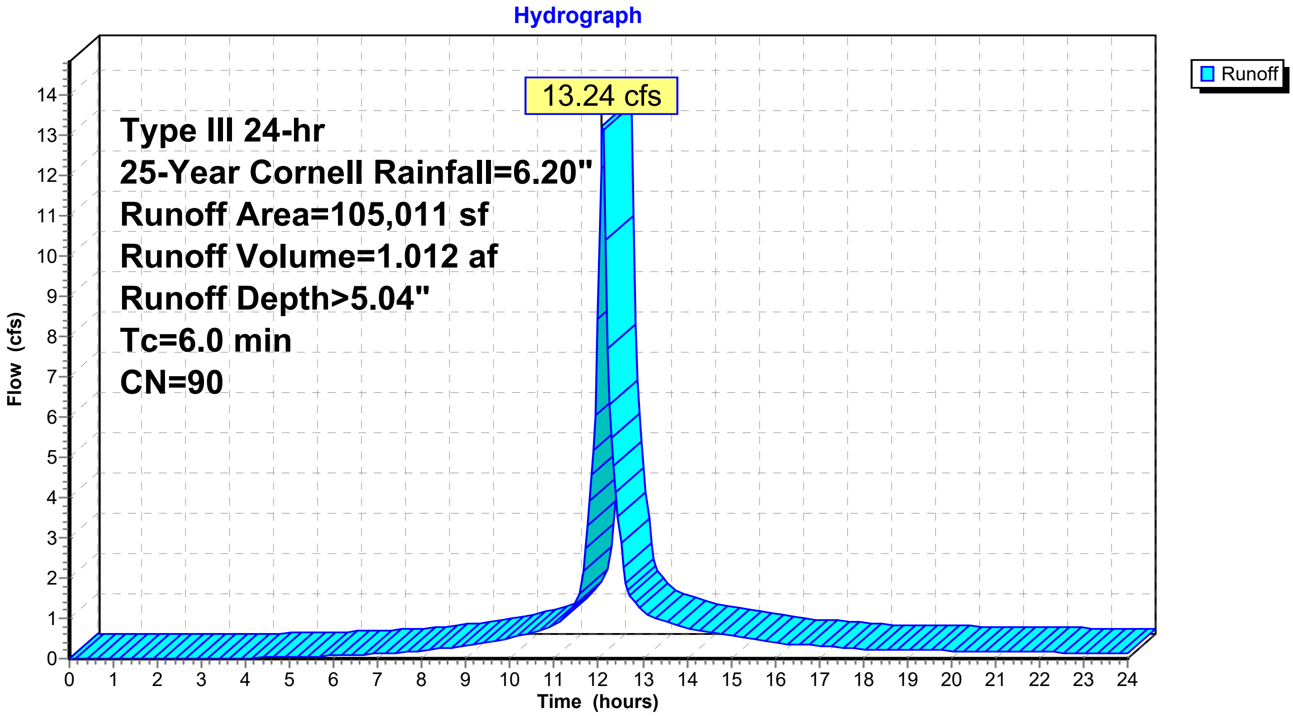
Runoff = 13.24 cfs @ 12.09 hrs, Volume= 1.012 af, Depth> 5.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
23,761	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
62,625	98	Paved parking, HSG B
105,011	90	Weighted Average
23,761		22.63% Pervious Area
81,250		77.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1B: HVMA Lot



Summary for Subcatchment EX-2: South Portion of Lot

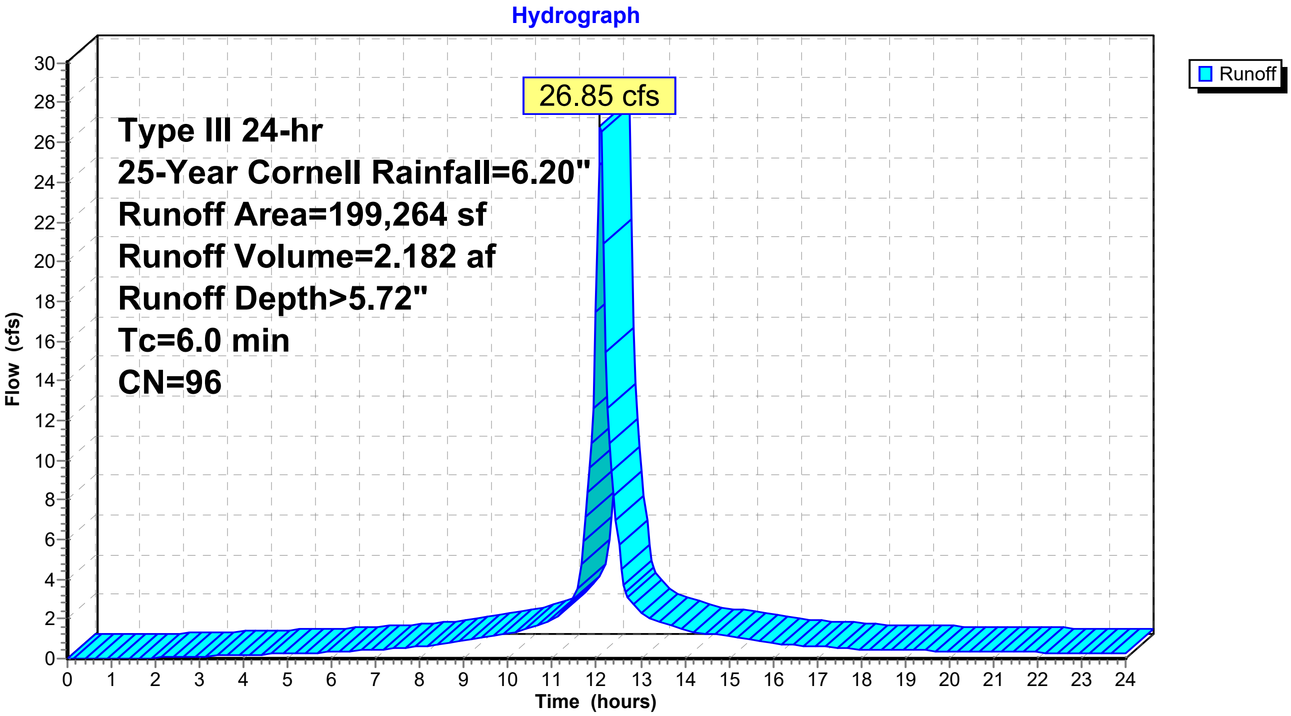
Runoff = 26.85 cfs @ 12.09 hrs, Volume= 2.182 af, Depth> 5.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
12,988	61	>75% Grass cover, Good, HSG B
172,371	98	Roofs, HSG B
13,905	98	Paved parking, HSG B
199,264	96	Weighted Average
12,988		6.52% Pervious Area
186,276		93.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-2: South Portion of Lot



Summary for Subcatchment EX-3A: East Portion of Lot

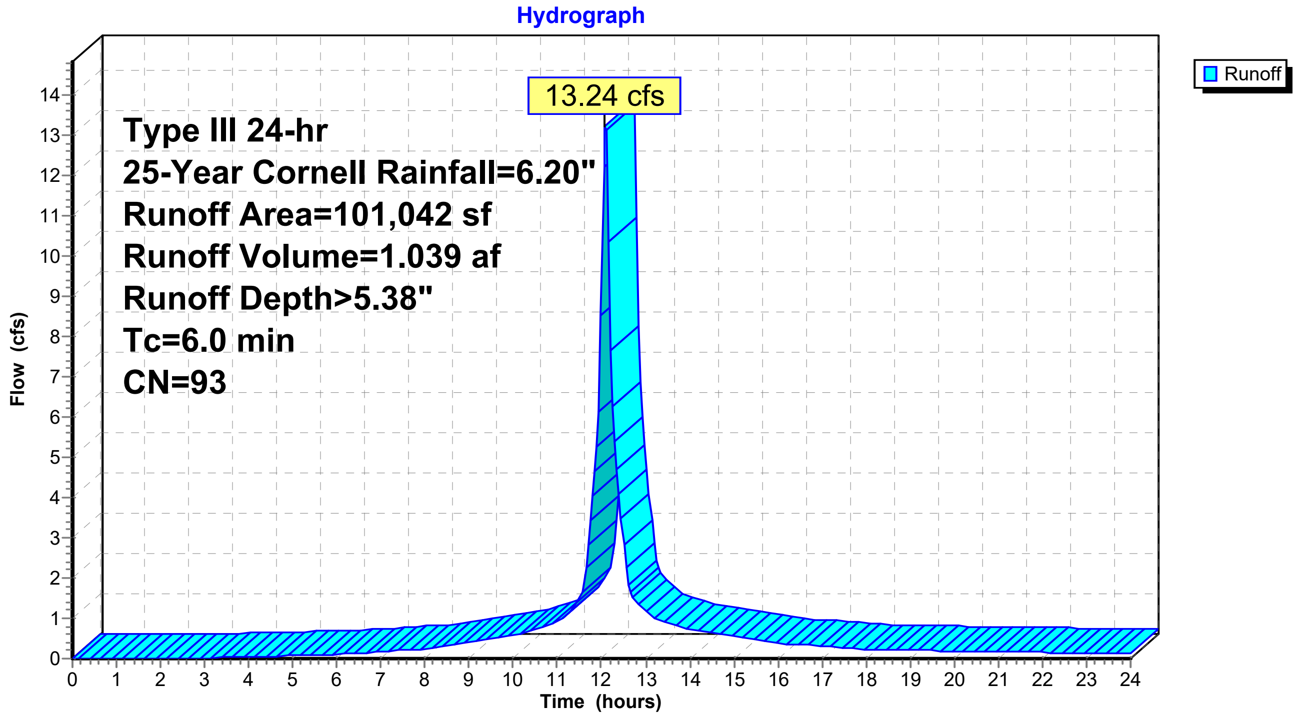
Runoff = 13.24 cfs @ 12.09 hrs, Volume= 1.039 af, Depth> 5.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
12,868	61	>75% Grass cover, Good, HSG B
9,302	98	Roofs, HSG B
78,872	98	Paved parking, HSG B
101,042	93	Weighted Average
12,868		12.74% Pervious Area
88,174		87.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-3A: East Portion of Lot



Summary for Subcatchment HDEX-3B: Home Depot Parking

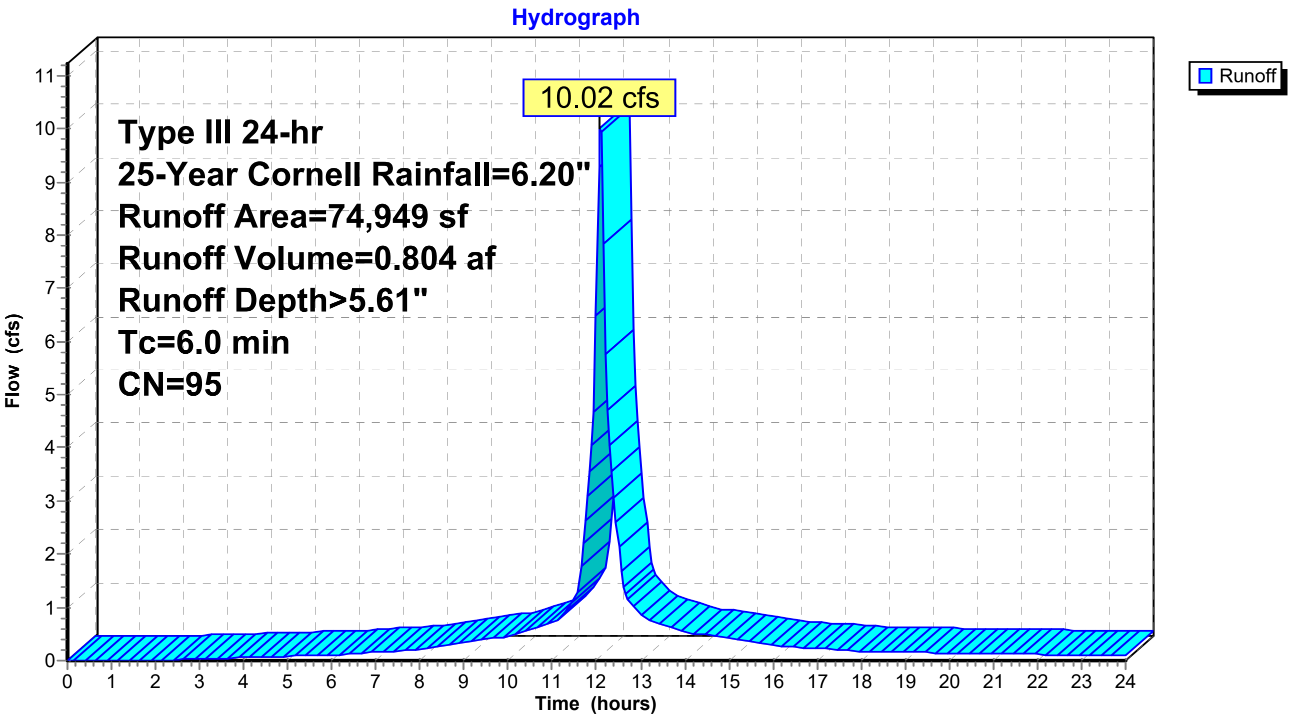
Runoff = 10.02 cfs @ 12.09 hrs, Volume= 0.804 af, Depth> 5.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
5,183	61	>75% Grass cover, Good, HSG B
69,766	98	Paved parking, HSG B
74,949	95	Weighted Average
5,183		6.92% Pervious Area
69,766		93.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDEX-3B: Home Depot Parking

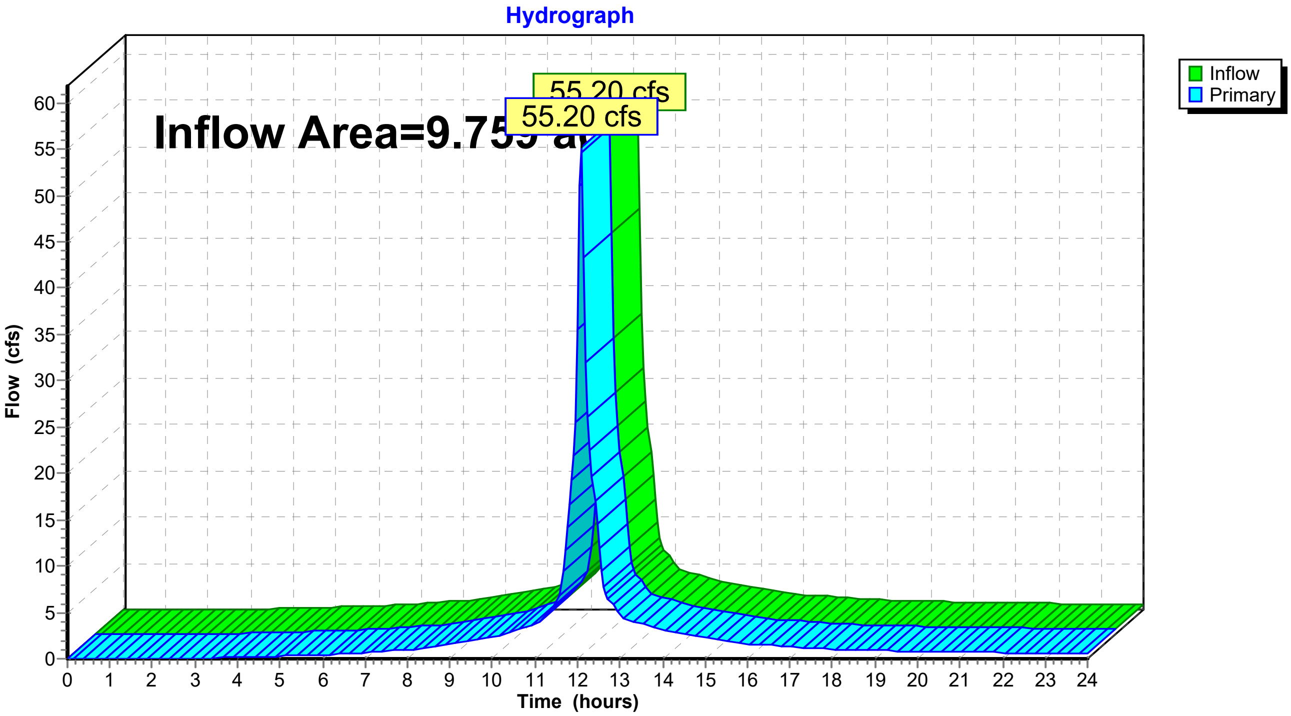


Summary for Link POA-1: 30" Pipe

Inflow Area = 9.759 ac, 87.56% Impervious, Inflow Depth > 5.29" for 25-Year Cornell event
Inflow = 55.20 cfs @ 12.09 hrs, Volume= 4.304 af
Primary = 55.20 cfs @ 12.09 hrs, Volume= 4.304 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

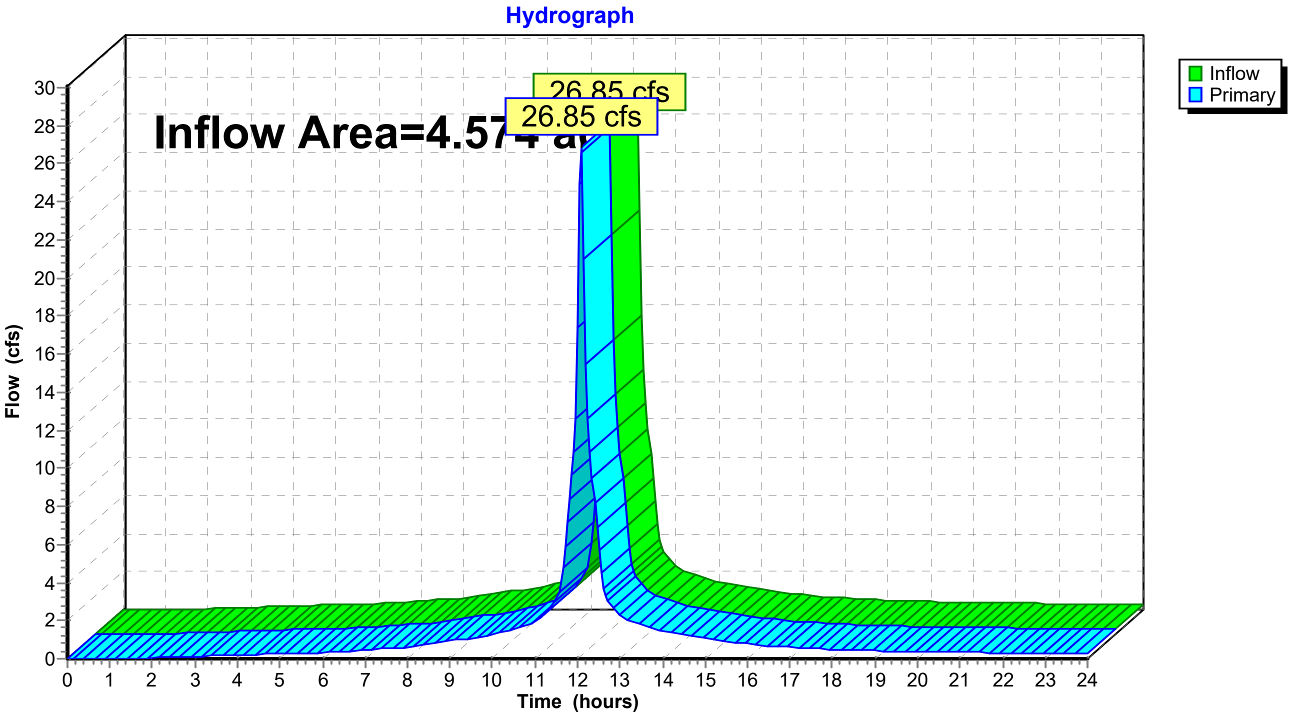


Summary for Link POA-2: 15" Pipe

Inflow Area = 4.574 ac, 93.48% Impervious, Inflow Depth > 5.72" for 25-Year Cornell event
Inflow = 26.85 cfs @ 12.09 hrs, Volume= 2.182 af
Primary = 26.85 cfs @ 12.09 hrs, Volume= 2.182 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

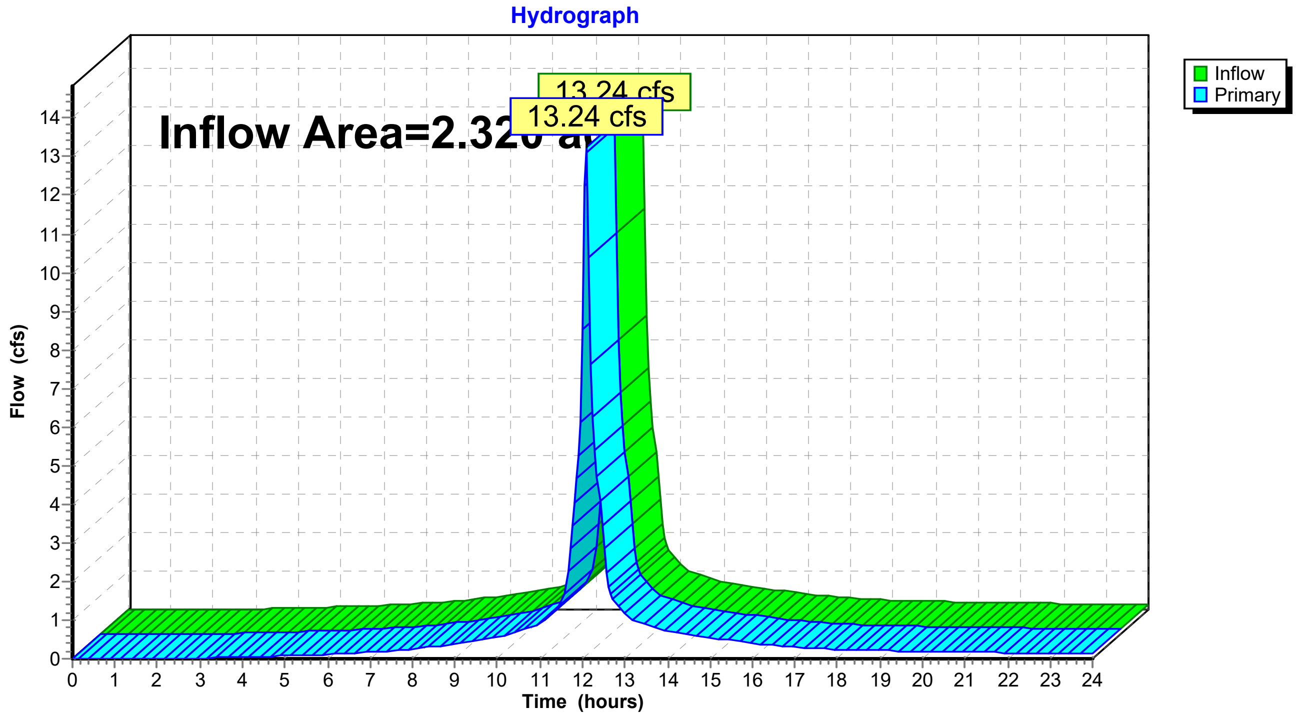


Summary for Link POA-3A: 24" Pipe

Inflow Area =	2.320 ac,	87.26% Impervious,	Inflow Depth > 5.38"	for 25-Year Cornell event	
Inflow =	13.24 cfs @	12.09 hrs,	Volume=	1.039 af	
Primary =	13.24 cfs @	12.09 hrs,	Volume=	1.039 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3A: 24" Pipe

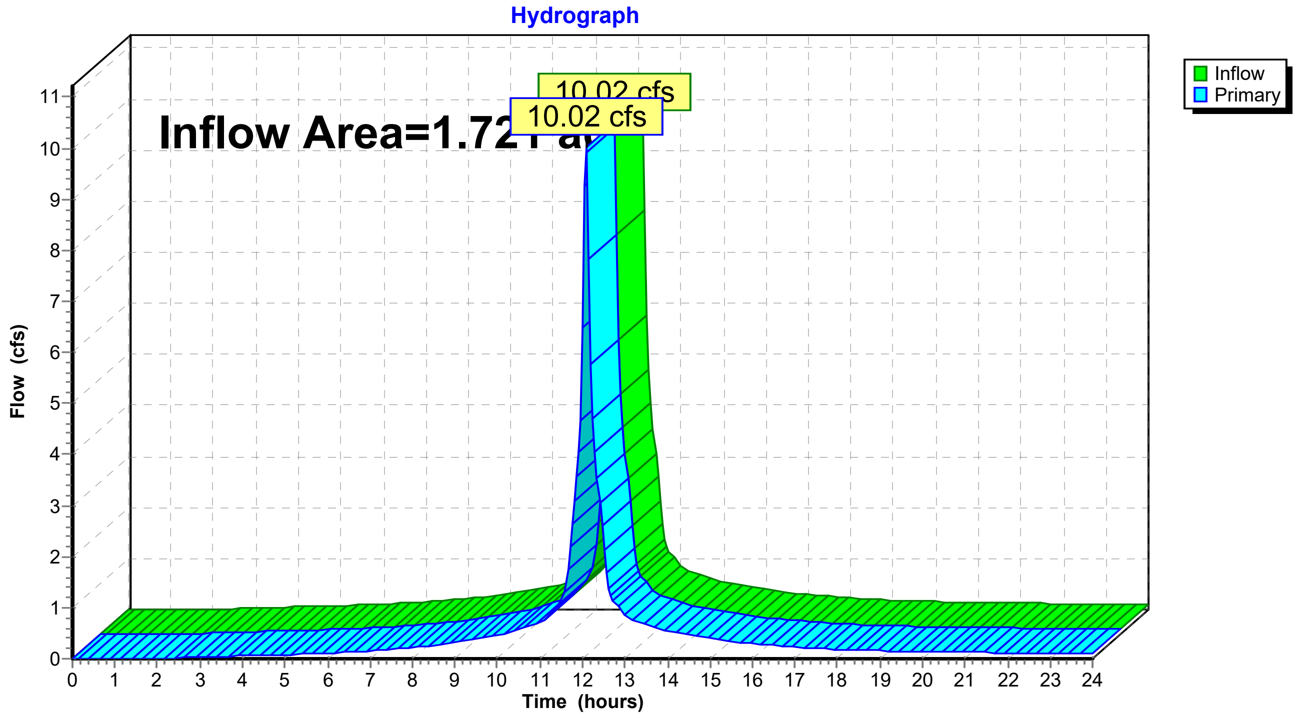


Summary for Link POA-3B: 18" Pipe

Inflow Area = 1.721 ac, 93.08% Impervious, Inflow Depth > 5.61" for 25-Year Cornell event
Inflow = 10.02 cfs @ 12.09 hrs, Volume= 0.804 af
Primary = 10.02 cfs @ 12.09 hrs, Volume= 0.804 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3B: 18" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1A: North Portion of Lot Runoff Area=320,092 sf 90.90% Impervious Runoff Depth>8.05"
Tc=6.0 min CN=93 Runoff=61.44 cfs 4.930 af

Subcatchment EX-1B: HVMA Lot Runoff Area=105,011 sf 77.37% Impervious Runoff Depth>7.69"
Tc=6.0 min CN=90 Runoff=19.72 cfs 1.544 af

Subcatchment EX-2: South Portion of Lot Runoff Area=199,264 sf 93.48% Impervious Runoff Depth>8.41"
Tc=6.0 min CN=96 Runoff=38.82 cfs 3.207 af

Subcatchment EX-3A: East Portion of Lot Runoff Area=101,042 sf 87.26% Impervious Runoff Depth>8.05"
Tc=6.0 min CN=93 Runoff=19.39 cfs 1.556 af

Subcatchment HDEX-3B: Home Depot Runoff Area=74,949 sf 93.08% Impervious Runoff Depth>8.29"
Tc=6.0 min CN=95 Runoff=14.54 cfs 1.189 af

Link POA-1: 30" Pipe Inflow=81.16 cfs 6.475 af
Primary=81.16 cfs 6.475 af

Link POA-2: 15" Pipe Inflow=38.82 cfs 3.207 af
Primary=38.82 cfs 3.207 af

Link POA-3A: 24" Pipe Inflow=19.39 cfs 1.556 af
Primary=19.39 cfs 1.556 af

Link POA-3B: 18" Pipe Inflow=14.54 cfs 1.189 af
Primary=14.54 cfs 1.189 af

Total Runoff Area = 18.374 ac Runoff Volume = 12.427 af Average Runoff Depth = 8.12"
10.48% Pervious = 1.926 ac 89.52% Impervious = 16.447 ac

Summary for Subcatchment EX-1A: North Portion of Lot

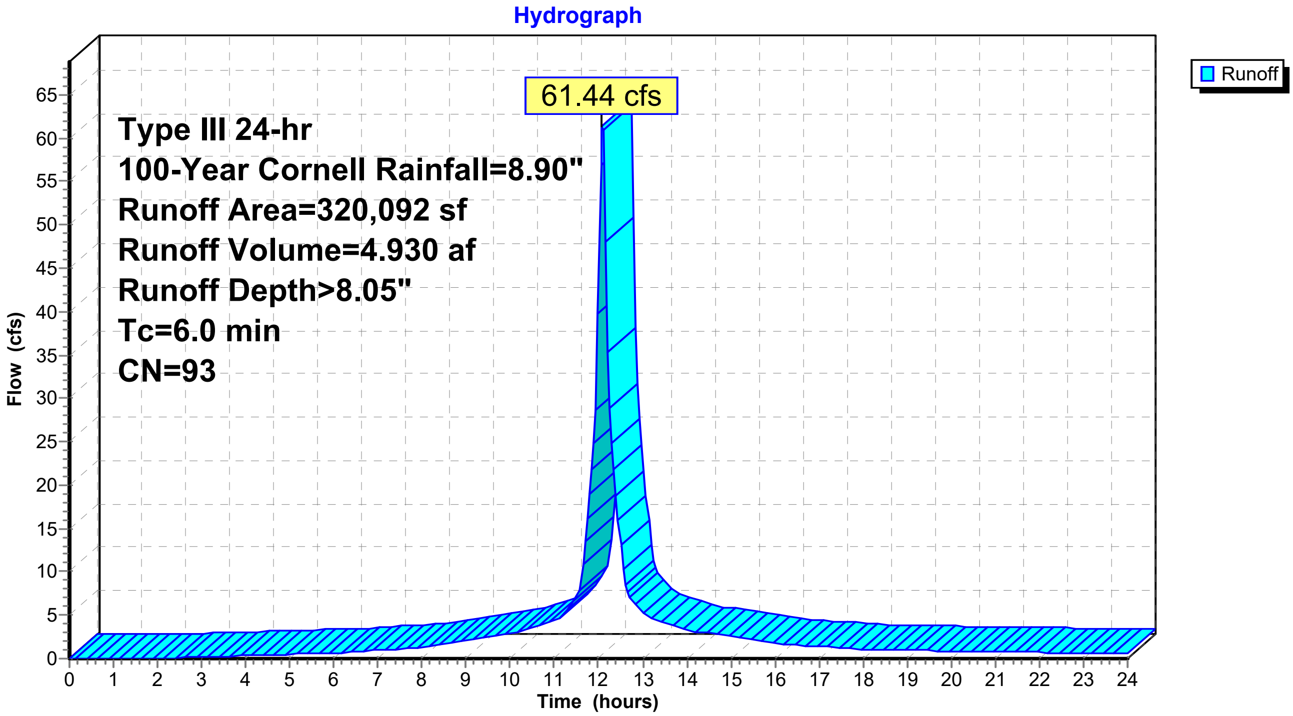
Runoff = 61.44 cfs @ 12.09 hrs, Volume= 4.930 af, Depth> 8.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
29,113	39	>75% Grass cover, Good, HSG A
49,302	98	Roofs, HSG A
241,677	98	Paved parking, HSG A
320,092	93	Weighted Average
29,113		9.10% Pervious Area
290,979		90.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1A: North Portion of Lot



Summary for Subcatchment EX-1B: HVMA Lot

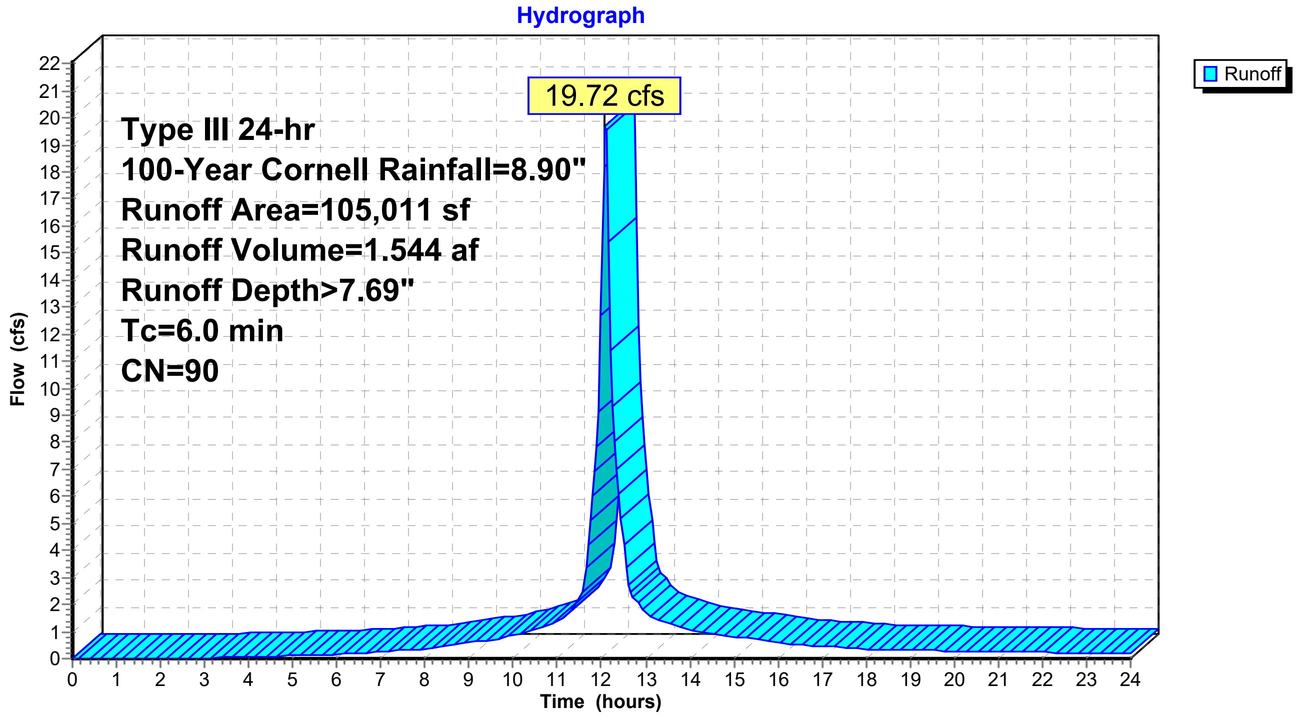
Runoff = 19.72 cfs @ 12.09 hrs, Volume= 1.544 af, Depth> 7.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
23,761	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
62,625	98	Paved parking, HSG B
105,011	90	Weighted Average
23,761		22.63% Pervious Area
81,250		77.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-1B: HVMA Lot



Summary for Subcatchment EX-2: South Portion of Lot

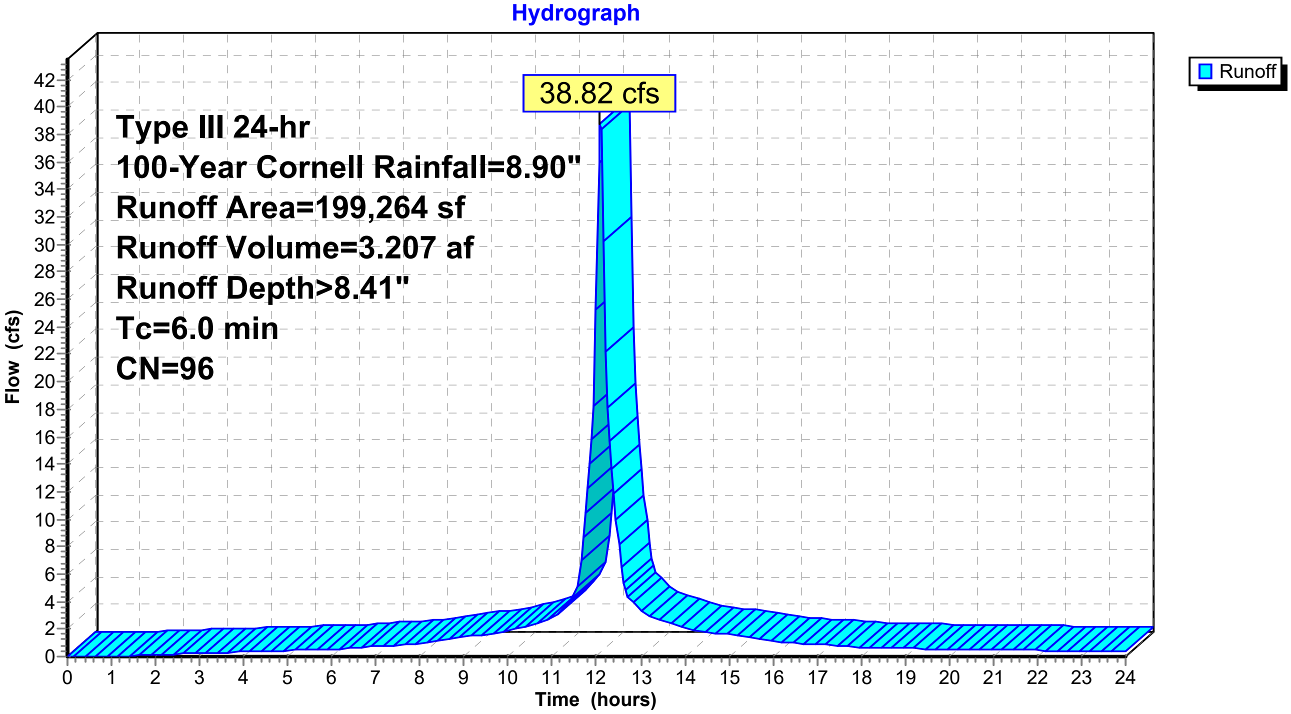
Runoff = 38.82 cfs @ 12.09 hrs, Volume= 3.207 af, Depth> 8.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
12,988	61	>75% Grass cover, Good, HSG B
172,371	98	Roofs, HSG B
13,905	98	Paved parking, HSG B
199,264	96	Weighted Average
12,988		6.52% Pervious Area
186,276		93.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-2: South Portion of Lot



Summary for Subcatchment EX-3A: East Portion of Lot

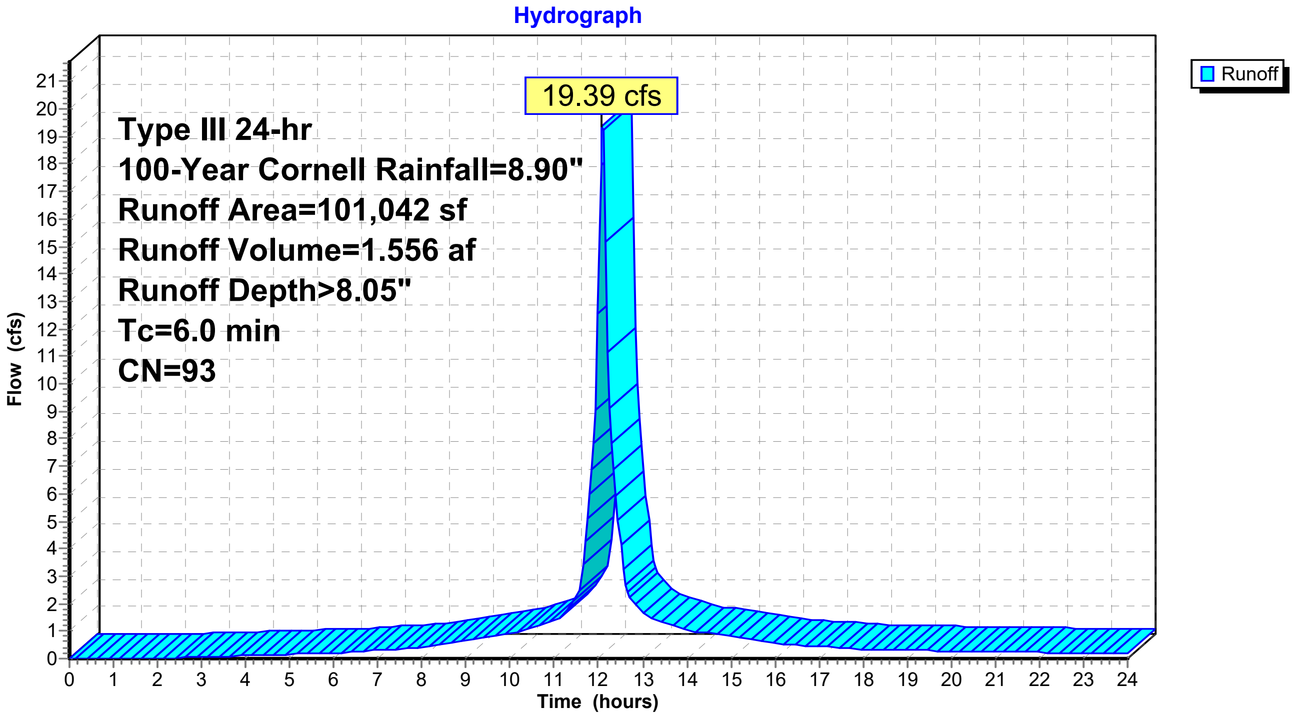
Runoff = 19.39 cfs @ 12.09 hrs, Volume= 1.556 af, Depth> 8.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
12,868	61	>75% Grass cover, Good, HSG B
9,302	98	Roofs, HSG B
78,872	98	Paved parking, HSG B
101,042	93	Weighted Average
12,868		12.74% Pervious Area
88,174		87.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment EX-3A: East Portion of Lot



Summary for Subcatchment HDEX-3B: Home Depot Parking

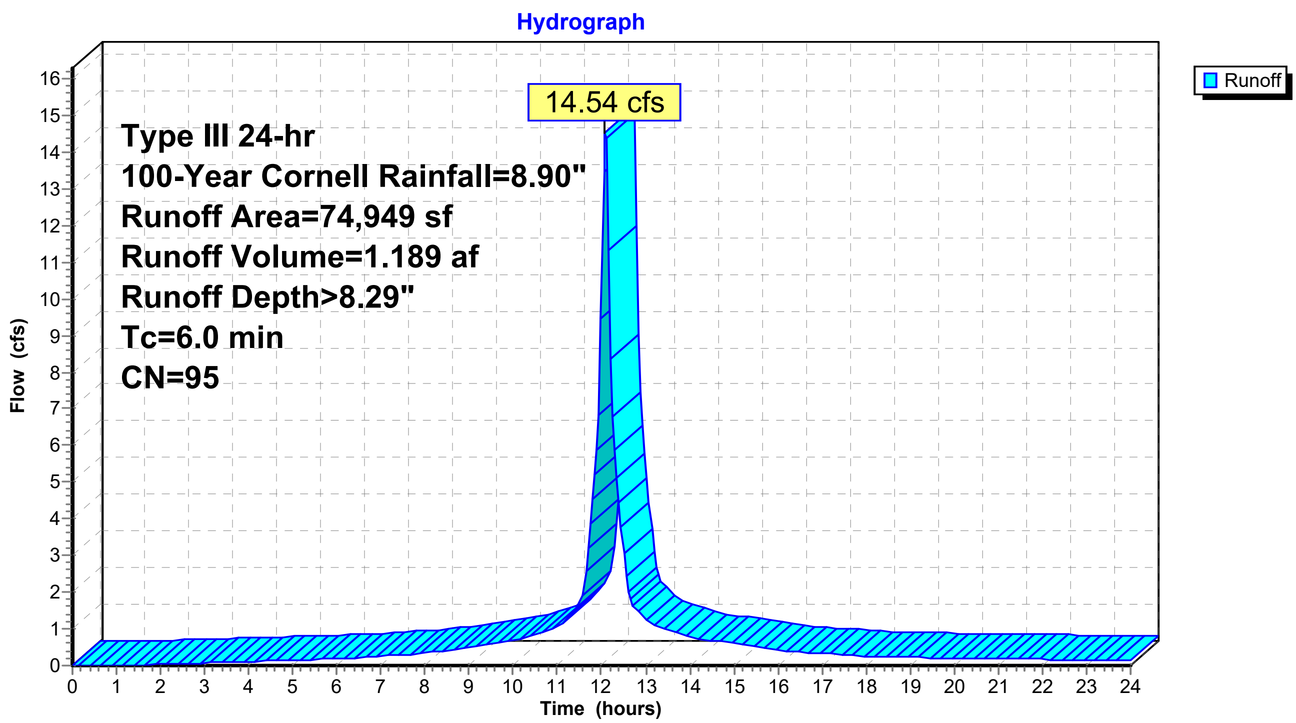
Runoff = 14.54 cfs @ 12.09 hrs, Volume= 1.189 af, Depth> 8.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
5,183	61	>75% Grass cover, Good, HSG B
69,766	98	Paved parking, HSG B
74,949	95	Weighted Average
5,183		6.92% Pervious Area
69,766		93.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDEX-3B: Home Depot Parking

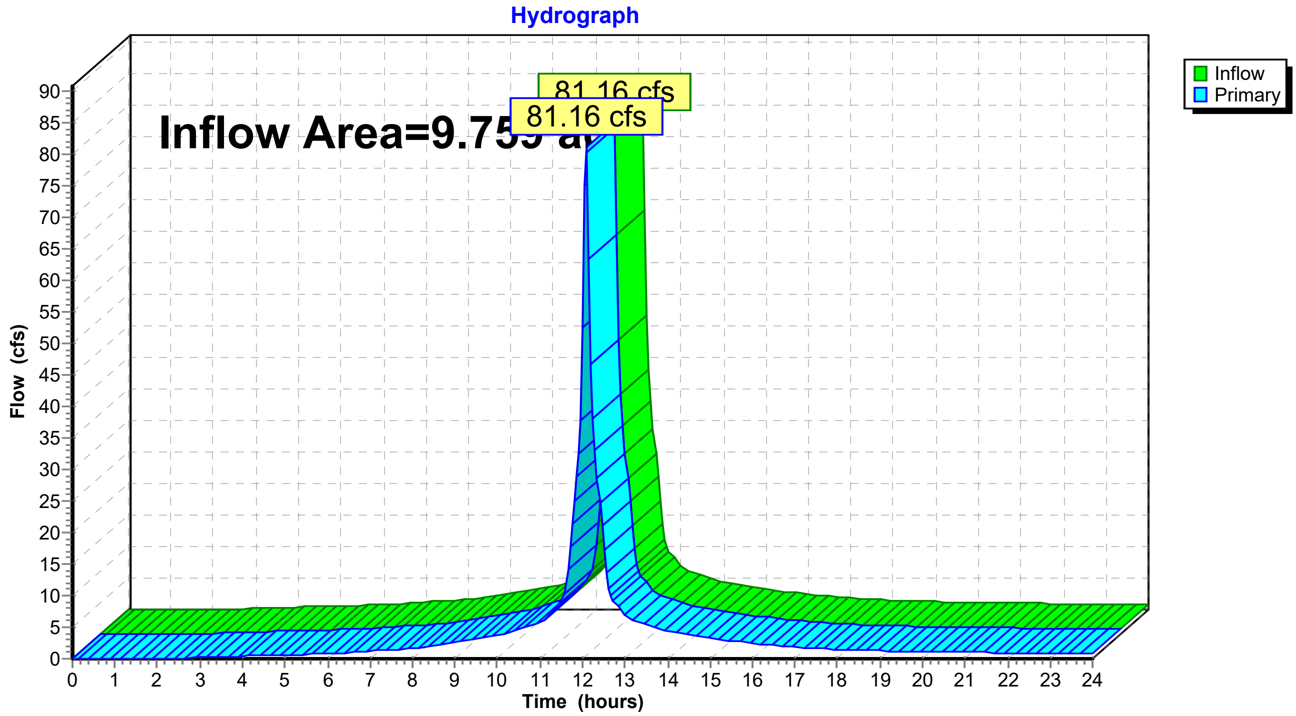


Summary for Link POA-1: 30" Pipe

Inflow Area =	9.759 ac, 87.56% Impervious, Inflow Depth > 7.96"		for 100-Year Cornell event
Inflow =	81.16 cfs @ 12.09 hrs, Volume=	6.475 af	
Primary =	81.16 cfs @ 12.09 hrs, Volume=	6.475 af, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

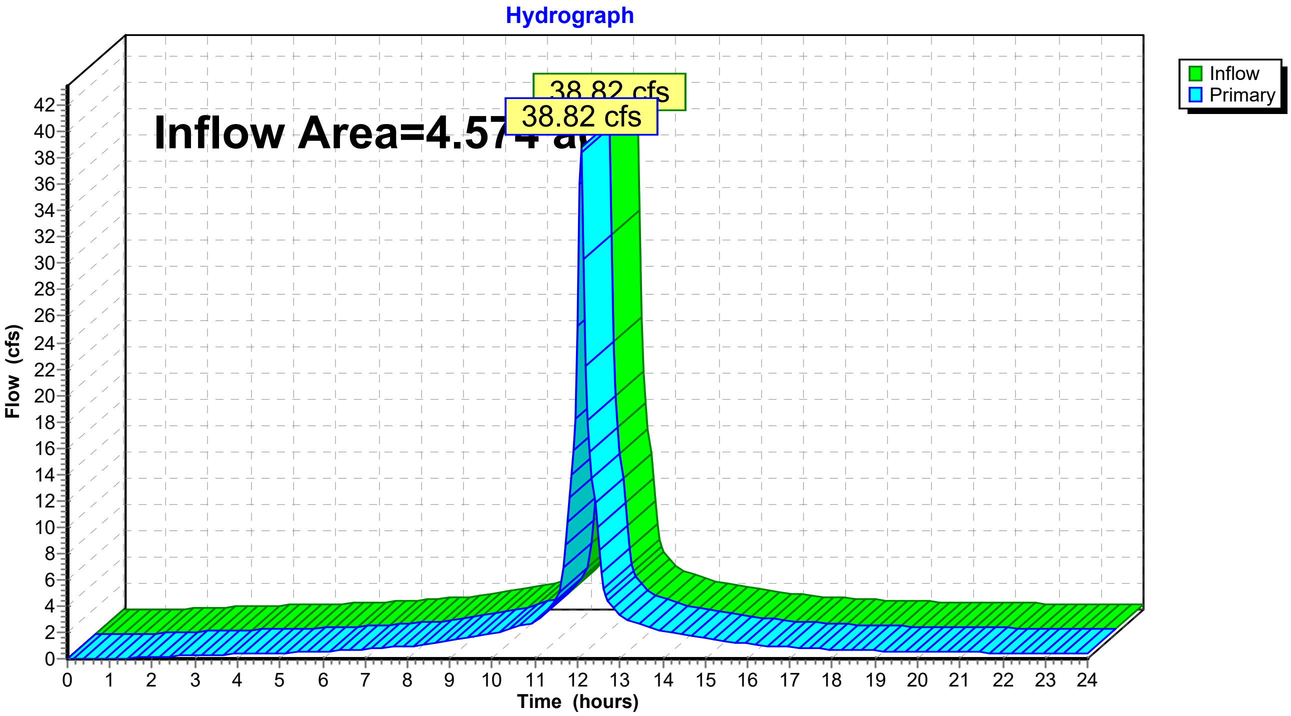


Summary for Link POA-2: 15" Pipe

Inflow Area = 4.574 ac, 93.48% Impervious, Inflow Depth > 8.41" for 100-Year Cornell event
Inflow = 38.82 cfs @ 12.09 hrs, Volume= 3.207 af
Primary = 38.82 cfs @ 12.09 hrs, Volume= 3.207 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

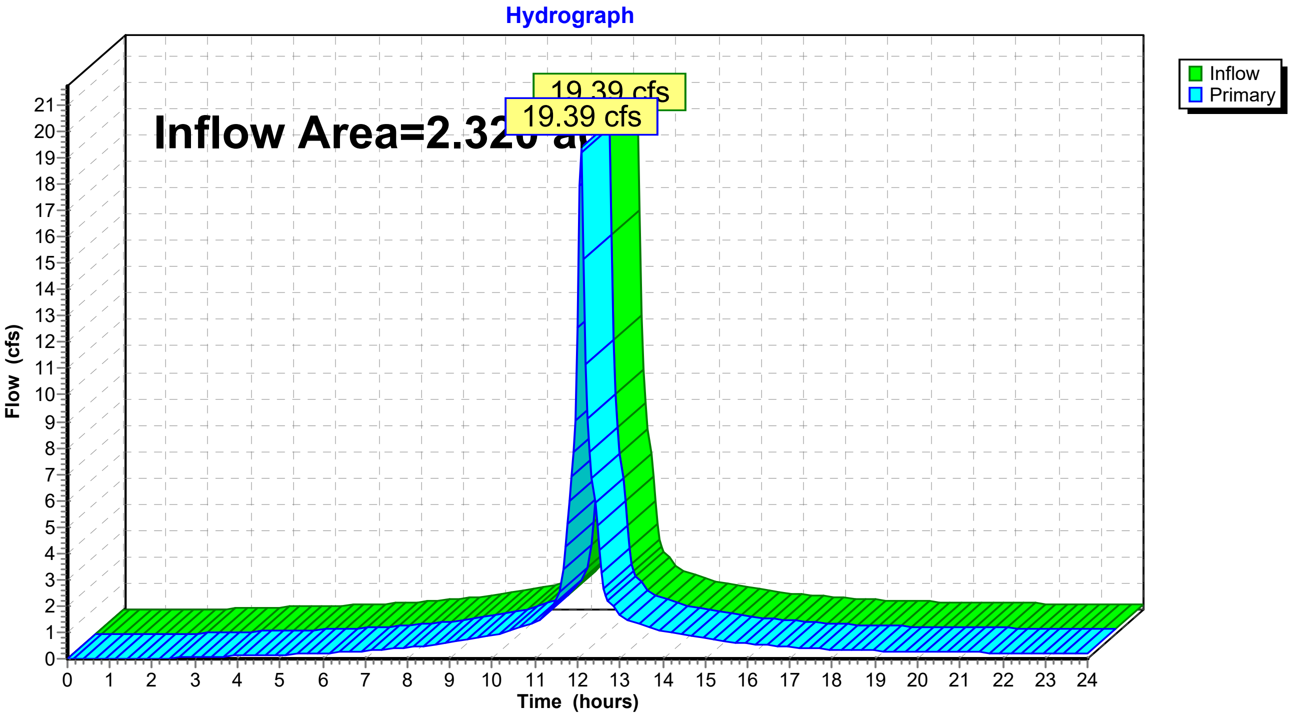


Summary for Link POA-3A: 24" Pipe

Inflow Area = 2.320 ac, 87.26% Impervious, Inflow Depth > 8.05" for 100-Year Cornell event
Inflow = 19.39 cfs @ 12.09 hrs, Volume= 1.556 af
Primary = 19.39 cfs @ 12.09 hrs, Volume= 1.556 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3A: 24" Pipe

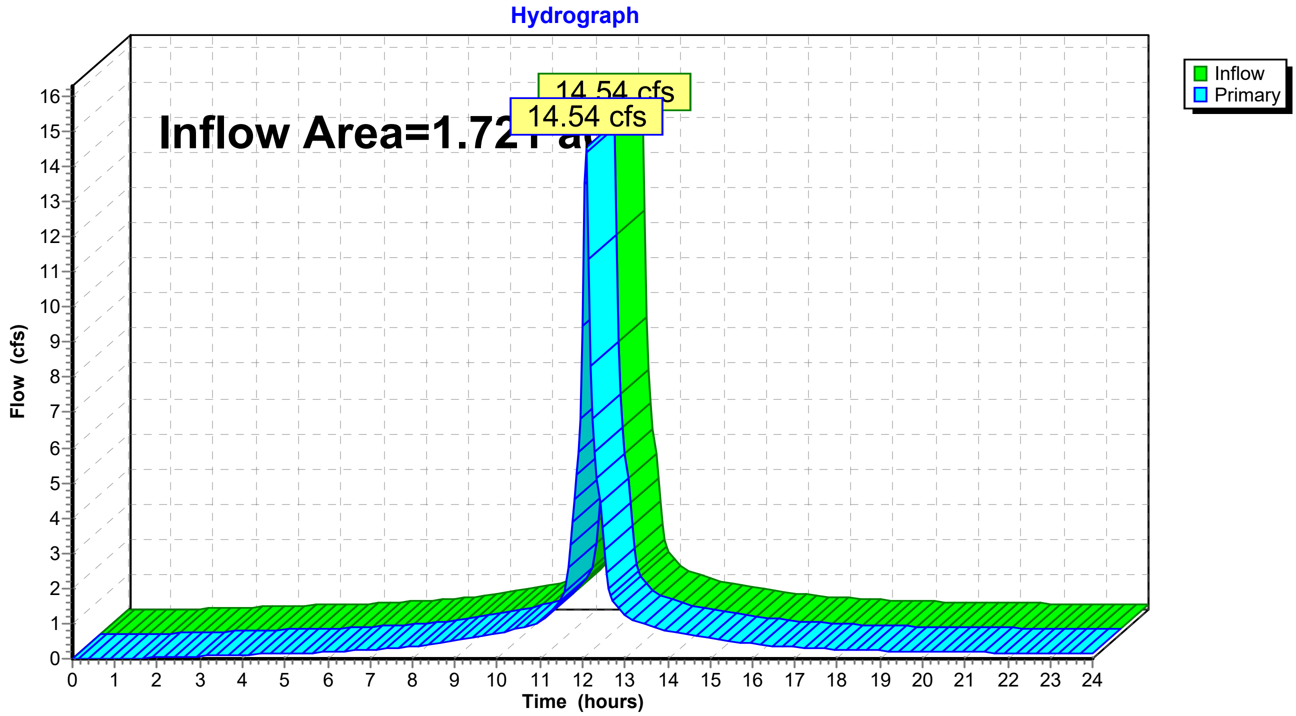


Summary for Link POA-3B: 18" Pipe

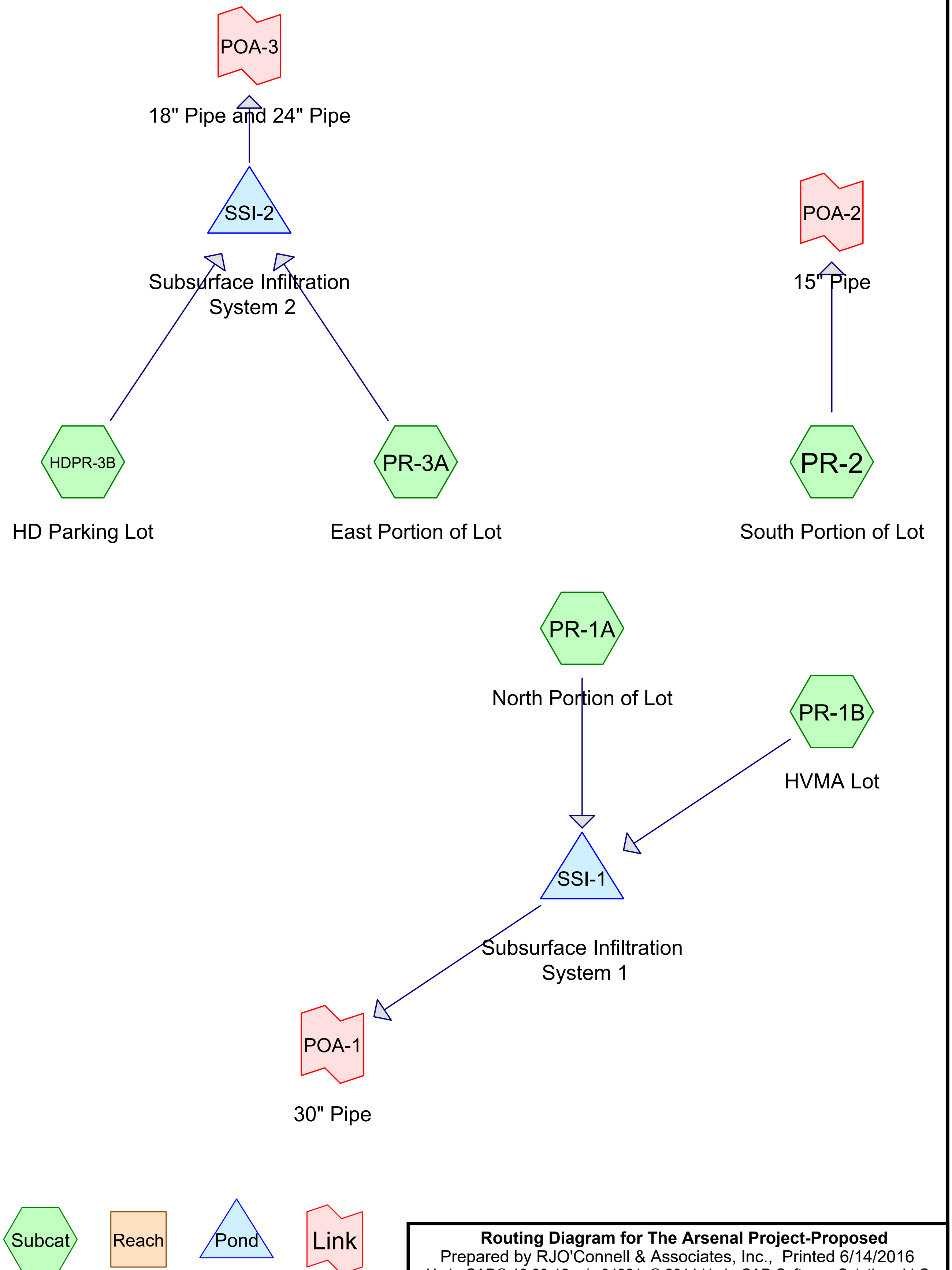
Inflow Area = 1.721 ac, 93.08% Impervious, Inflow Depth > 8.29" for 100-Year Cornell event
Inflow = 14.54 cfs @ 12.09 hrs, Volume= 1.189 af
Primary = 14.54 cfs @ 12.09 hrs, Volume= 1.189 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3B: 18" Pipe



Post-Redevelopment Hydrological Computations



Routing Diagram for The Arsenal Project-Proposed
Prepared by RJO'Connell & Associates, Inc., Printed 6/14/2016
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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>2.44"
Tc=6.0 min CN=93 Runoff=4.17 cfs 0.313 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>2.75"
Tc=6.0 min CN=96 Runoff=26.48 cfs 2.069 af

Subcatchment PR-1B: HVMA Lot Runoff Area=116,176 sf 79.06% Impervious Runoff Depth>2.17"
Tc=6.0 min CN=90 Runoff=6.56 cfs 0.482 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>2.35"
Tc=6.0 min CN=92 Runoff=3.49 cfs 0.259 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>2.85"
Tc=6.0 min CN=97 Runoff=11.18 cfs 0.890 af

Pond SSI-1: Subsurface Infiltration System Peak Elev=16.54' Storage=34,381 cf Inflow=33.05 cfs 2.550 af
Discarded=5.99 cfs 2.548 af Primary=0.00 cfs 0.000 af Outflow=5.99 cfs 2.548 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=10.95' Storage=27,631 cf Inflow=15.34 cfs 1.203 af
Discarded=0.58 cfs 0.706 af Primary=0.51 cfs 0.101 af Outflow=1.08 cfs 0.807 af

Link POA-1: 30" Pipe Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link POA-2: 15" Pipe Inflow=3.49 cfs 0.259 af
Primary=3.49 cfs 0.259 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=0.51 cfs 0.101 af
Primary=0.51 cfs 0.101 af

Total Runoff Area = 18.303 ac Runoff Volume = 4.012 af Average Runoff Depth = 2.63"
7.59% Pervious = 1.390 ac 92.41% Impervious = 16.914 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

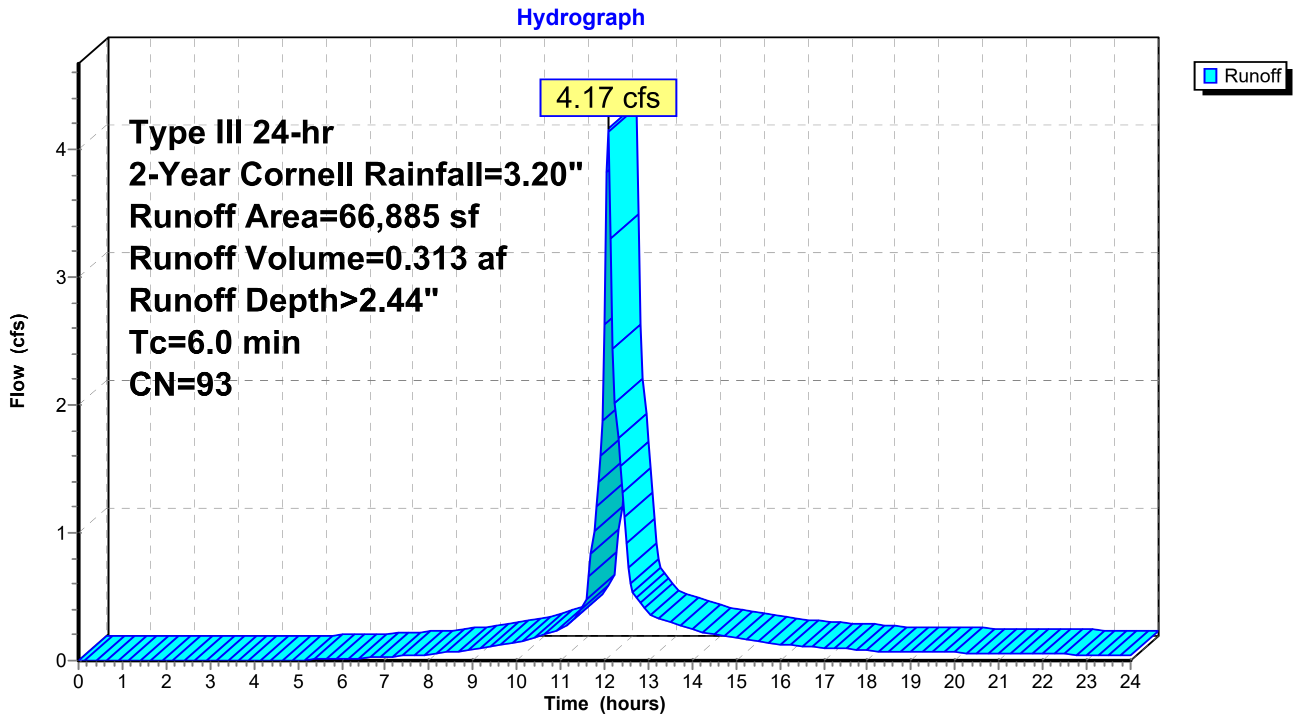
Runoff = 4.17 cfs @ 12.09 hrs, Volume= 0.313 af, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

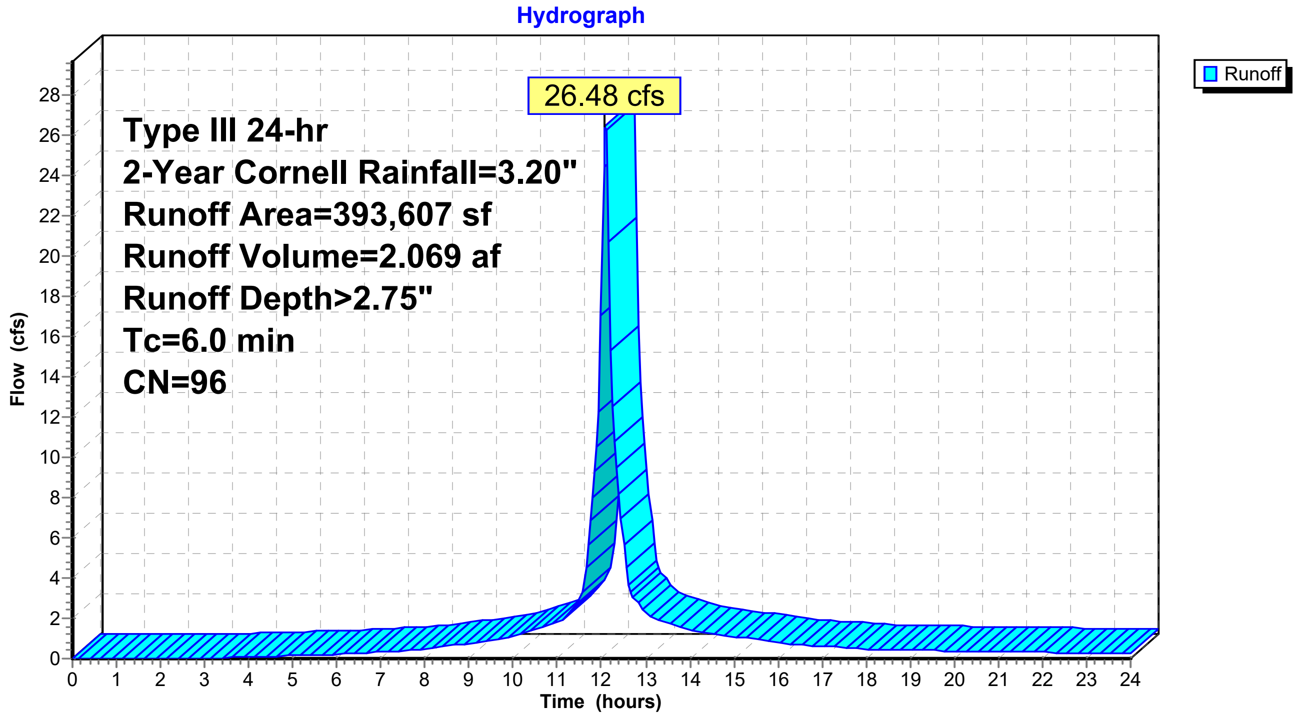
Runoff = 26.48 cfs @ 12.09 hrs, Volume= 2.069 af, Depth> 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

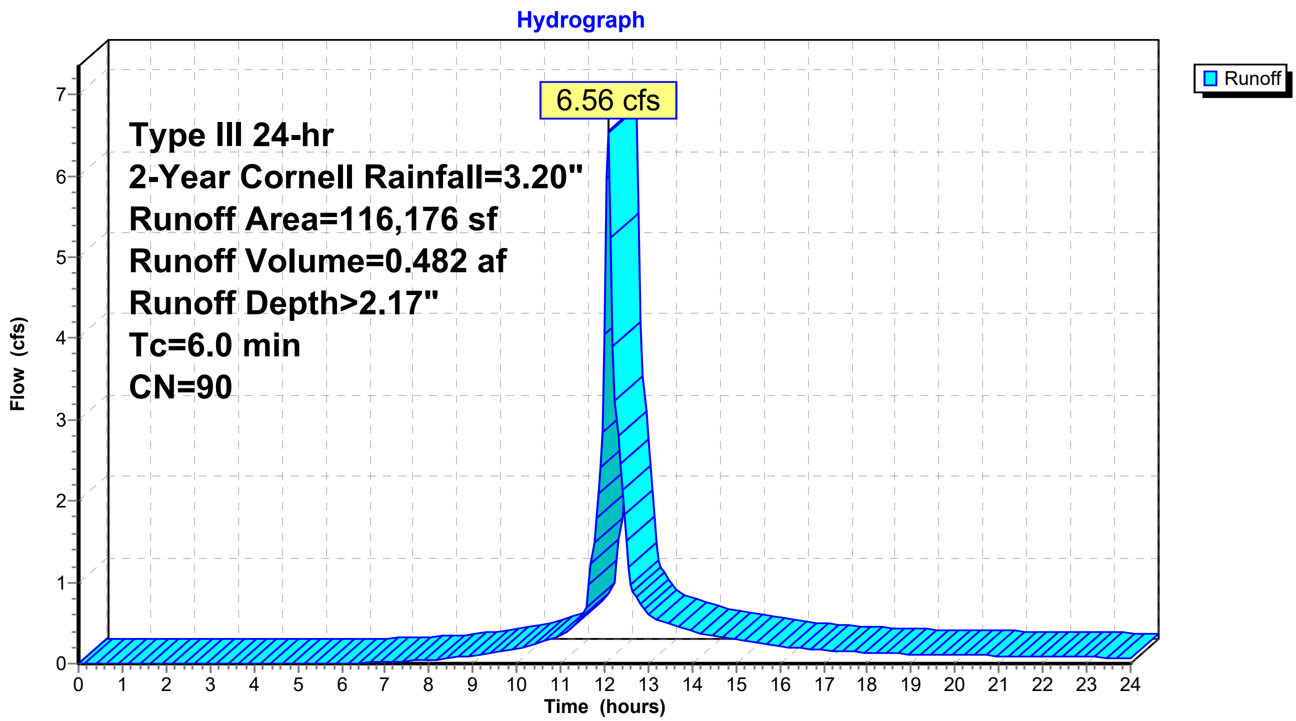
Runoff = 6.56 cfs @ 12.09 hrs, Volume= 0.482 af, Depth> 2.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
24,326	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
73,225	98	Paved parking, HSG B
116,176	90	Weighted Average
24,326		20.94% Pervious Area
91,850		79.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

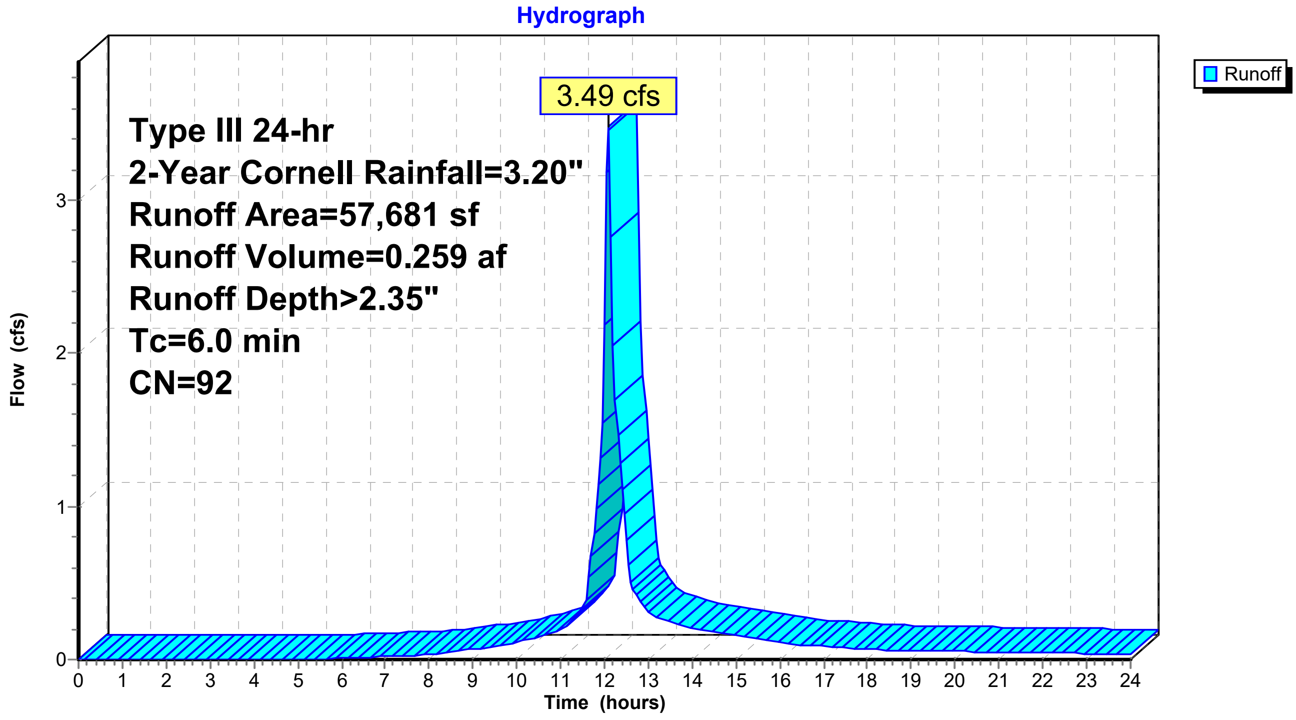
Runoff = 3.49 cfs @ 12.09 hrs, Volume= 0.259 af, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

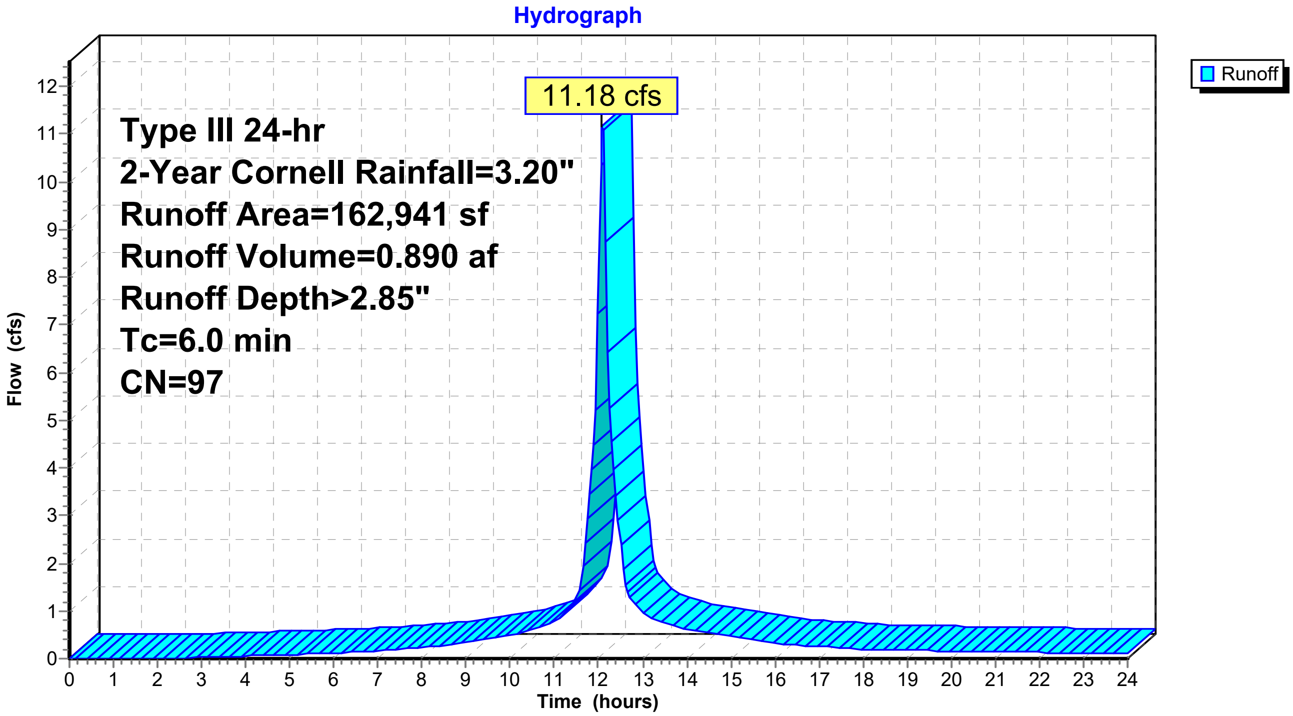
Runoff = 11.18 cfs @ 12.09 hrs, Volume= 0.890 af, Depth> 2.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area =	11.703 ac,	92.70% Impervious,	Inflow Depth > 2.62"	for 2-Year Cornell event
Inflow =	33.05 cfs @	12.09 hrs, Volume=	2.550 af	
Outflow =	5.99 cfs @	12.54 hrs, Volume=	2.548 af,	Atten= 82%, Lag= 27.3 min
Discarded =	5.99 cfs @	12.54 hrs, Volume=	2.548 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 16.54' @ 12.54 hrs Surf.Area= 14,652 sf Storage= 34,381 cf

Plug-Flow detention time= 43.1 min calculated for 2.548 af (100% of inflow)
Center-of-Mass det. time= 42.7 min (822.4 - 779.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=5.99 cfs @ 12.54 hrs HW=16.54' (Free Discharge)
↑—**2=Exfiltration** (Controls 5.99 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

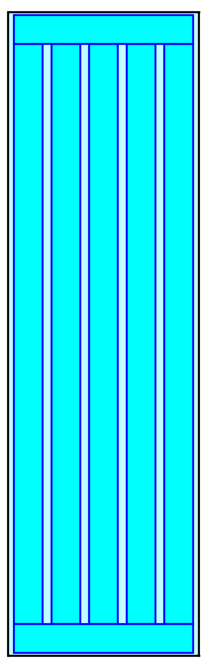
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

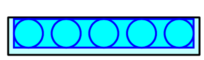
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 = 88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone Storage

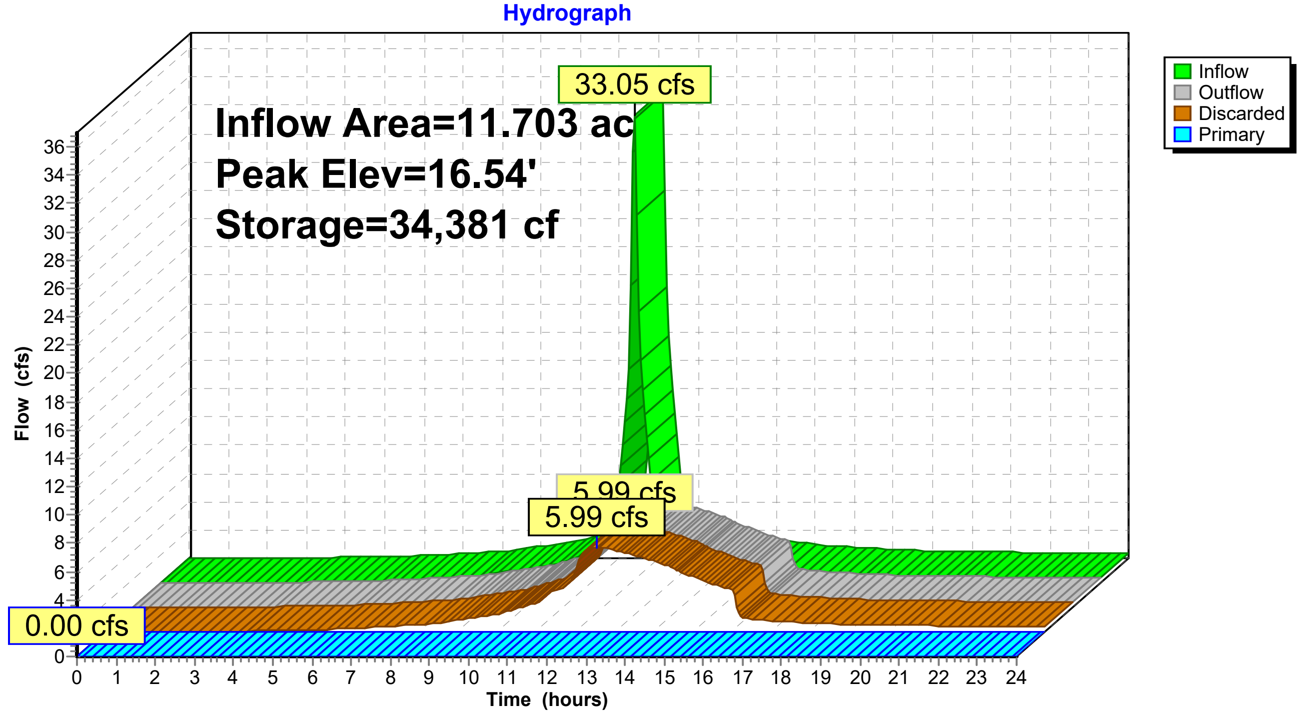
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth > 2.74" for 2-Year Cornell event
Inflow = 15.34 cfs @ 12.09 hrs, Volume= 1.203 af
Outflow = 1.08 cfs @ 13.41 hrs, Volume= 0.807 af, Atten= 93%, Lag= 79.2 min
Discarded = 0.58 cfs @ 13.41 hrs, Volume= 0.706 af
Primary = 0.51 cfs @ 13.41 hrs, Volume= 0.101 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 10.95' @ 13.41 hrs Surf.Area= 14,107 sf Storage= 27,631 cf

Plug-Flow detention time= 261.8 min calculated for 0.805 af (67% of inflow)
Center-of-Mass det. time= 166.5 min (939.0 - 772.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.58 cfs @ 13.41 hrs HW=10.95' (Free Discharge)
└─**3=Exfiltration** (Controls 0.58 cfs)

Primary OutFlow Max=0.50 cfs @ 13.41 hrs HW=10.95' (Free Discharge)
├─**1=Culvert** (Barrel Controls 0.25 cfs @ 1.95 fps)
└─**2=Culvert** (Barrel Controls 0.25 cfs @ 1.95 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

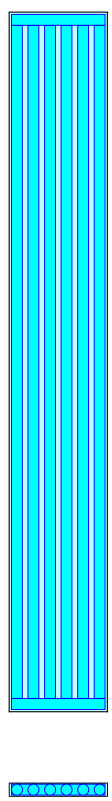
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 = 37,514.9 cf Chamber Storage

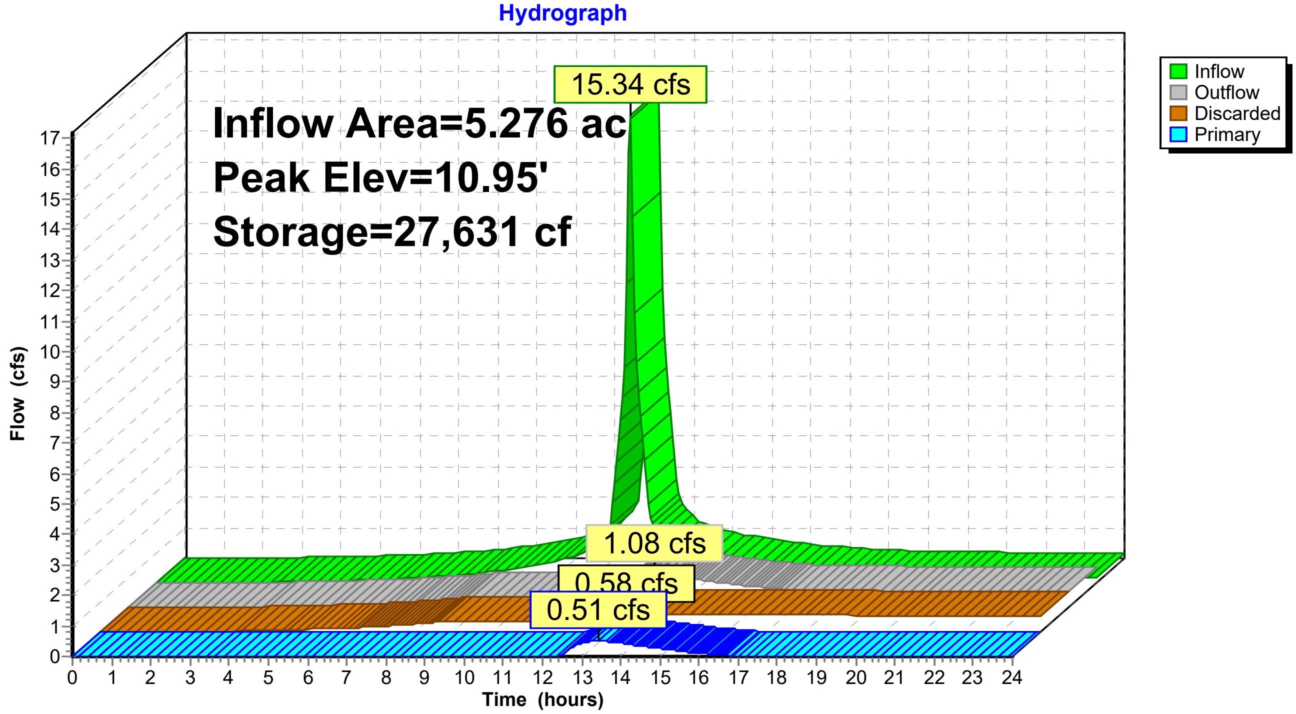
84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone



Pond SSI-2: Subsurface Infiltration System 2

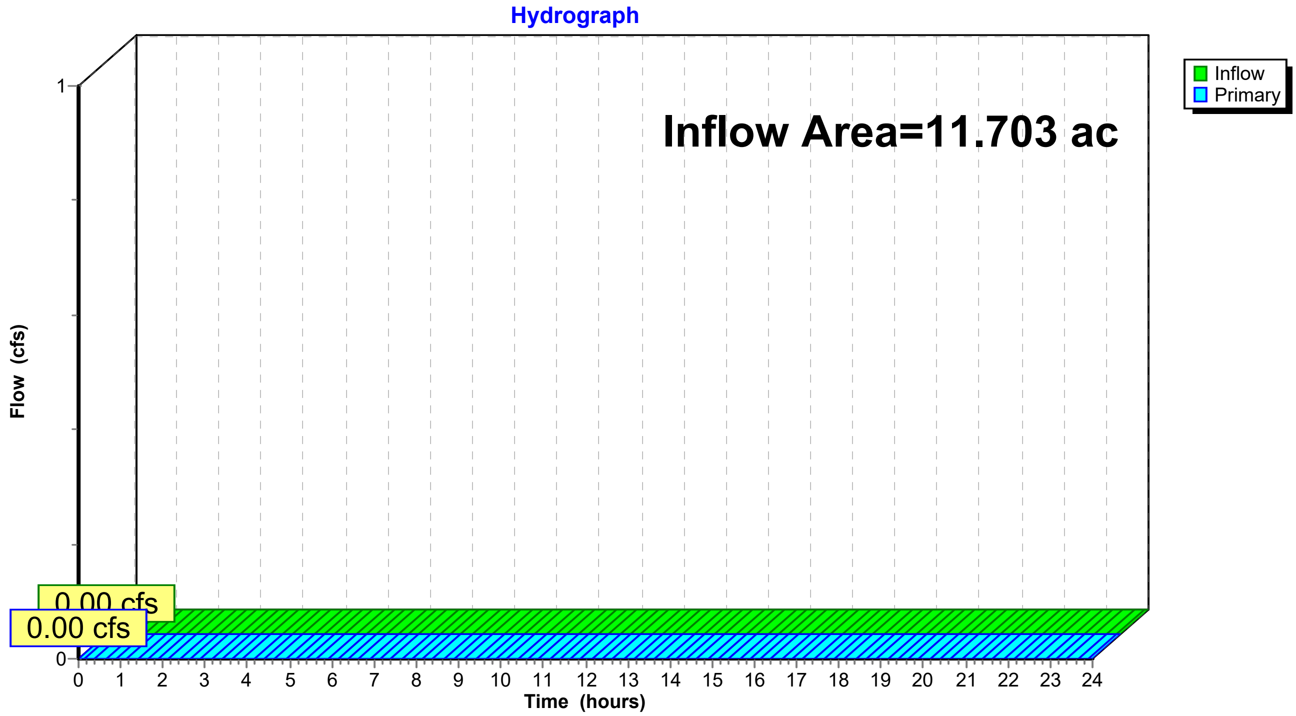


Summary for Link POA-1: 30" Pipe

Inflow Area =	11.703 ac,	92.70% Impervious,	Inflow Depth = 0.00"	for 2-Year Cornell event
Inflow =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

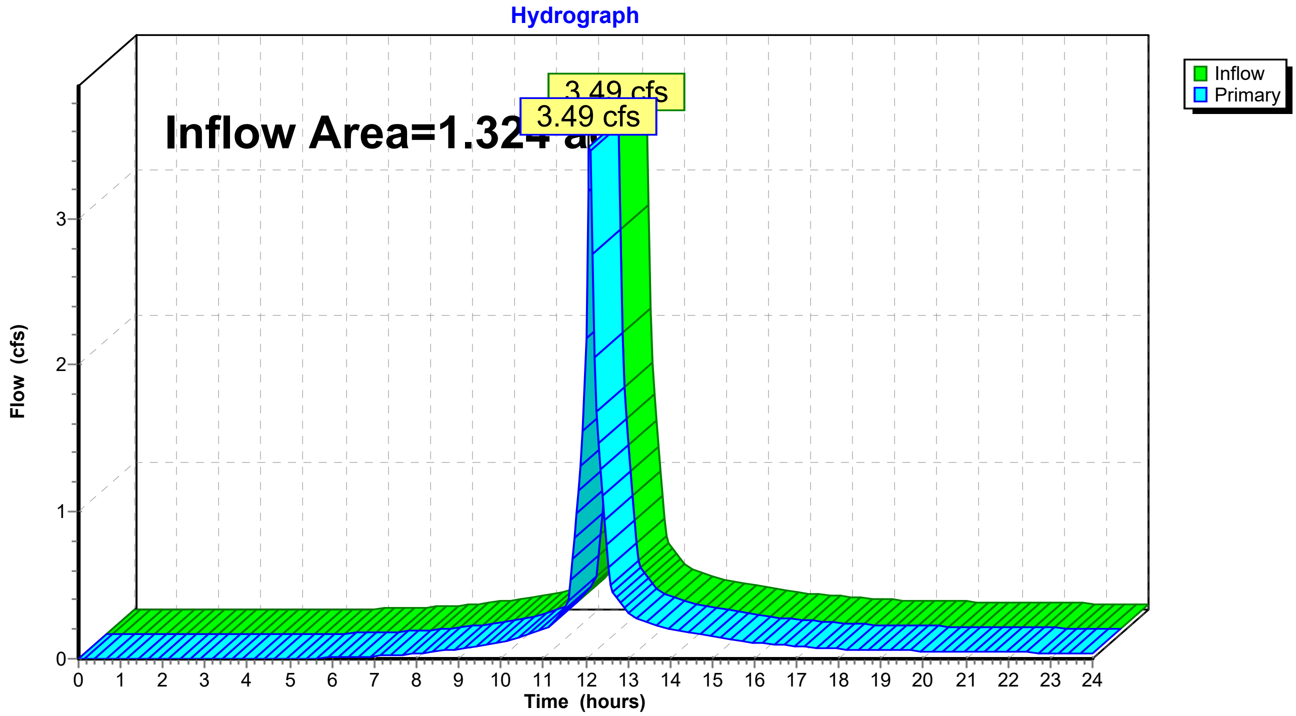


Summary for Link POA-2: 15" Pipe

Inflow Area = 1.324 ac, 83.32% Impervious, Inflow Depth > 2.35" for 2-Year Cornell event
Inflow = 3.49 cfs @ 12.09 hrs, Volume= 0.259 af
Primary = 3.49 cfs @ 12.09 hrs, Volume= 0.259 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

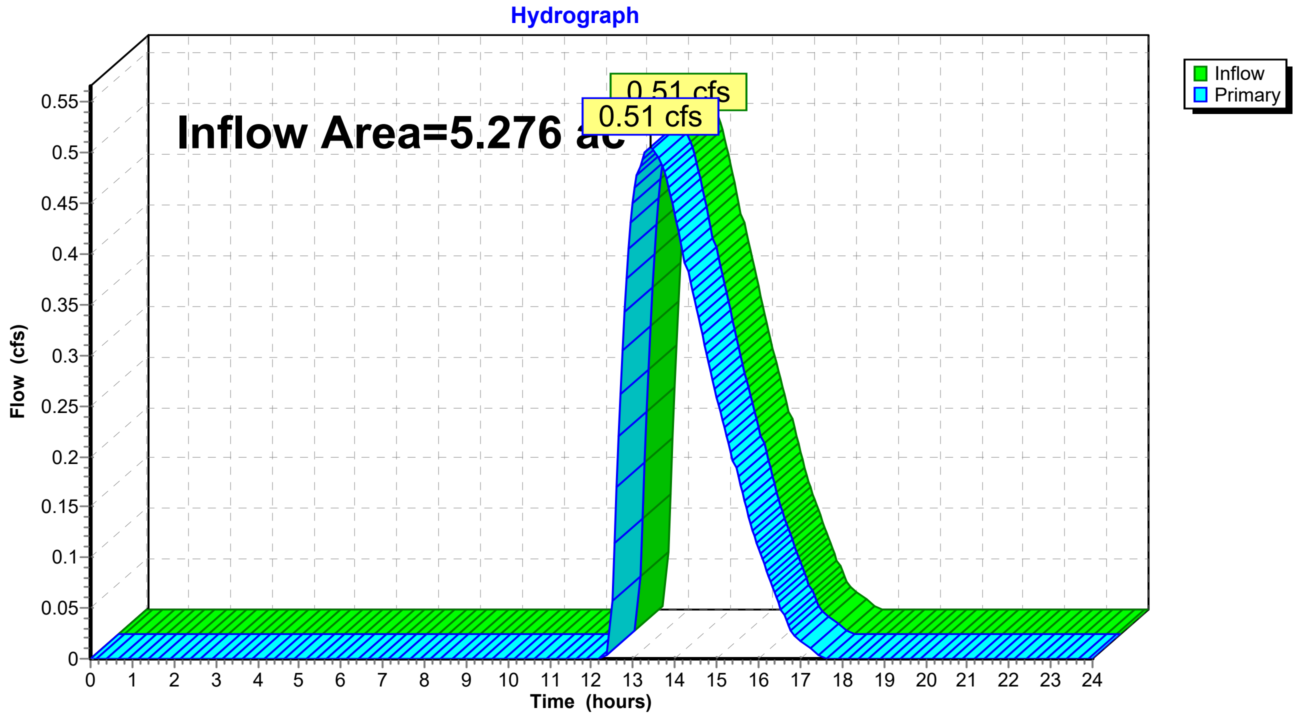


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 0.23" for 2-Year Cornell event
Inflow = 0.51 cfs @ 13.41 hrs, Volume= 0.101 af
Primary = 0.51 cfs @ 13.41 hrs, Volume= 0.101 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>4.10"
Tc=6.0 min CN=93 Runoff=6.79 cfs 0.524 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>4.43"
Tc=6.0 min CN=96 Runoff=41.59 cfs 3.336 af

Subcatchment PR-1B: HVMA Lot Runoff Area=116,176 sf 79.06% Impervious Runoff Depth>3.78"
Tc=6.0 min CN=90 Runoff=11.16 cfs 0.839 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>3.99"
Tc=6.0 min CN=92 Runoff=5.76 cfs 0.440 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>4.54"
Tc=6.0 min CN=97 Runoff=17.38 cfs 1.417 af

Pond SSI-1: Subsurface Infiltration System Peak Elev=18.97' Storage=63,702 cf Inflow=52.74 cfs 4.176 af
Discarded=7.69 cfs 4.173 af Primary=0.00 cfs 0.000 af Outflow=7.69 cfs 4.173 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=11.79' Storage=37,088 cf Inflow=24.17 cfs 1.941 af
Discarded=0.65 cfs 0.789 af Primary=6.69 cfs 0.681 af Outflow=7.34 cfs 1.470 af

Link POA-1: 30" Pipe Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link POA-2: 15" Pipe Inflow=5.76 cfs 0.440 af
Primary=5.76 cfs 0.440 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=6.69 cfs 0.681 af
Primary=6.69 cfs 0.681 af

Total Runoff Area = 18.303 ac Runoff Volume = 6.557 af Average Runoff Depth = 4.30"
7.59% Pervious = 1.390 ac 92.41% Impervious = 16.914 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

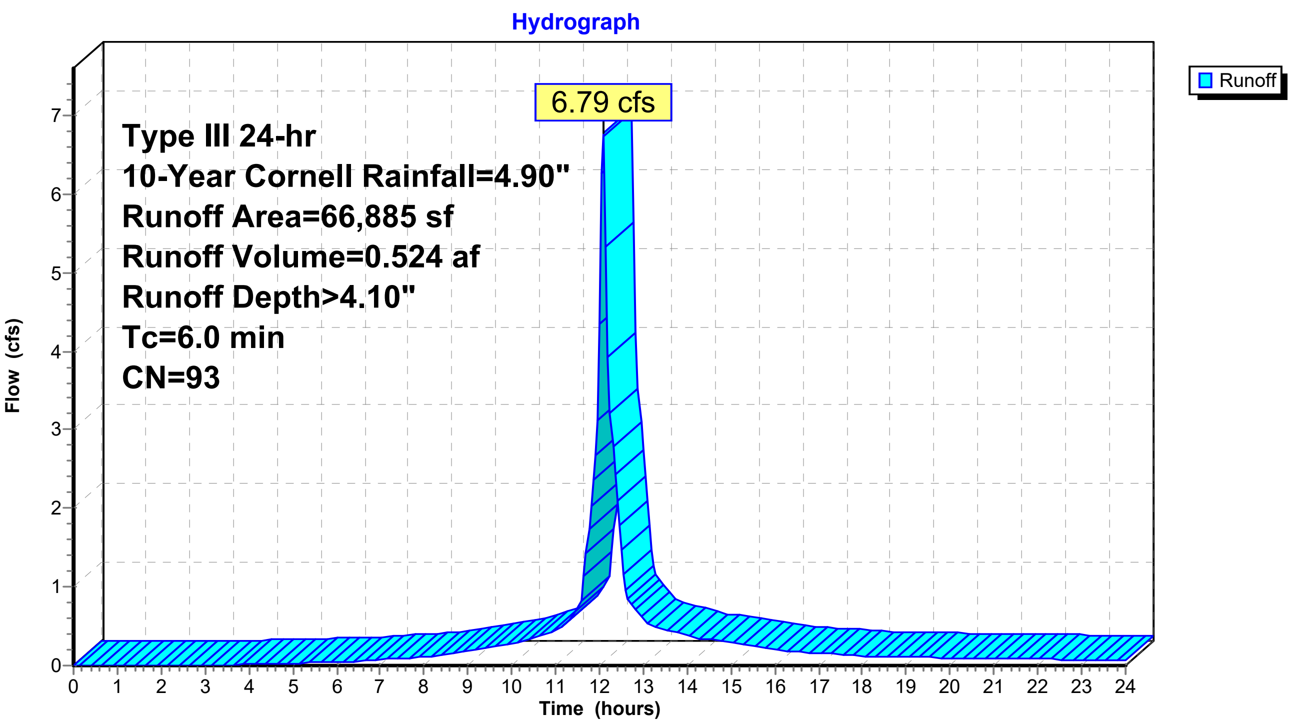
Runoff = 6.79 cfs @ 12.09 hrs, Volume= 0.524 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

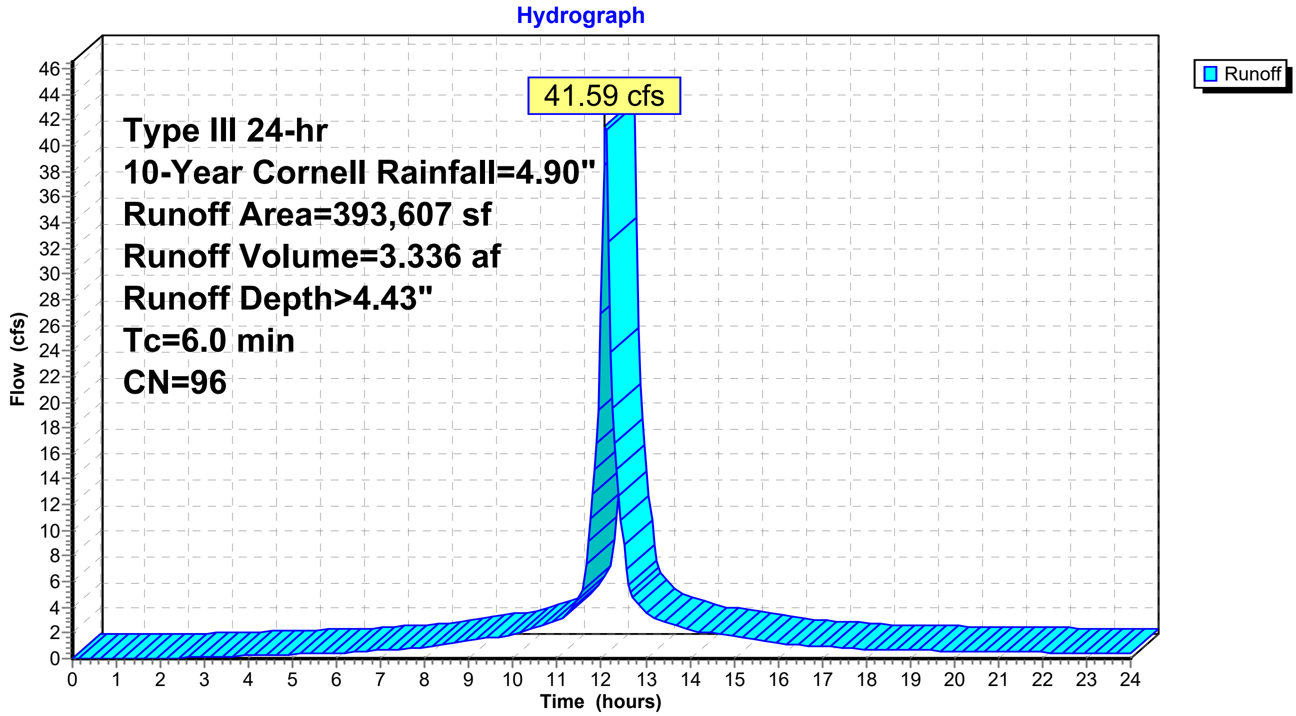
Runoff = 41.59 cfs @ 12.09 hrs, Volume= 3.336 af, Depth> 4.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

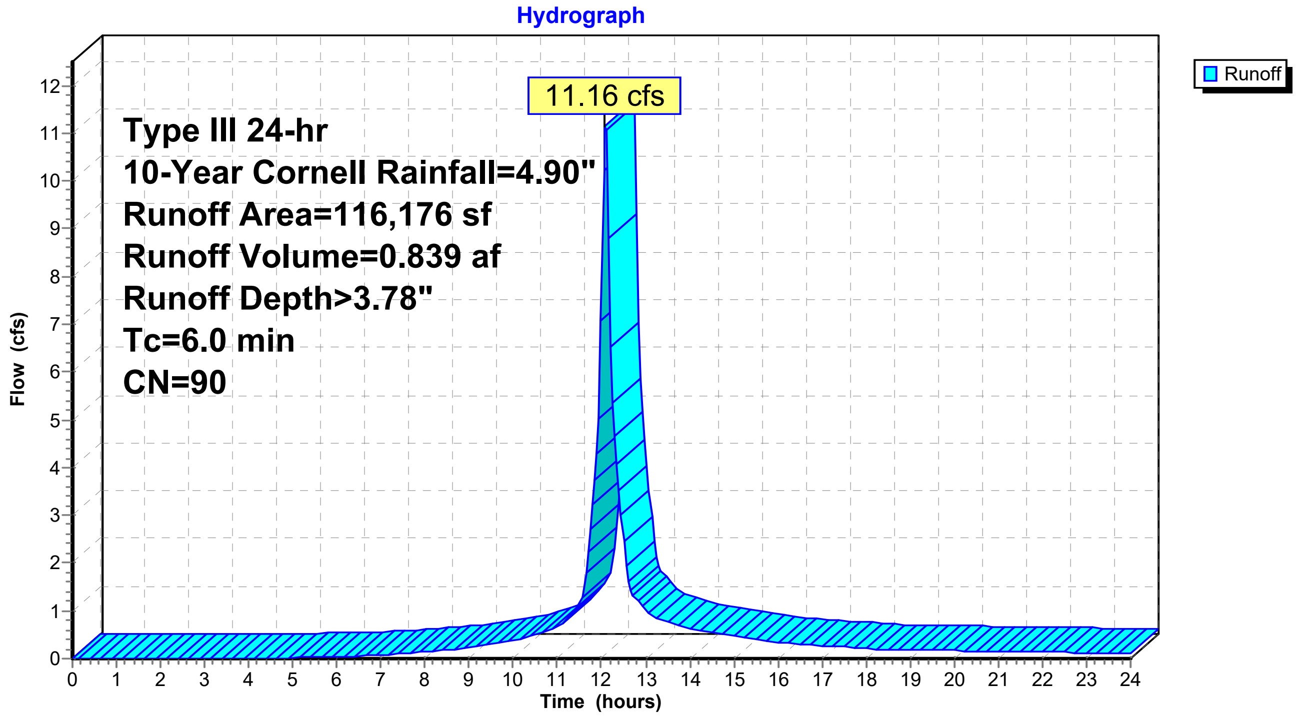
Runoff = 11.16 cfs @ 12.09 hrs, Volume= 0.839 af, Depth> 3.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
24,326	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
73,225	98	Paved parking, HSG B
116,176	90	Weighted Average
24,326		20.94% Pervious Area
91,850		79.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

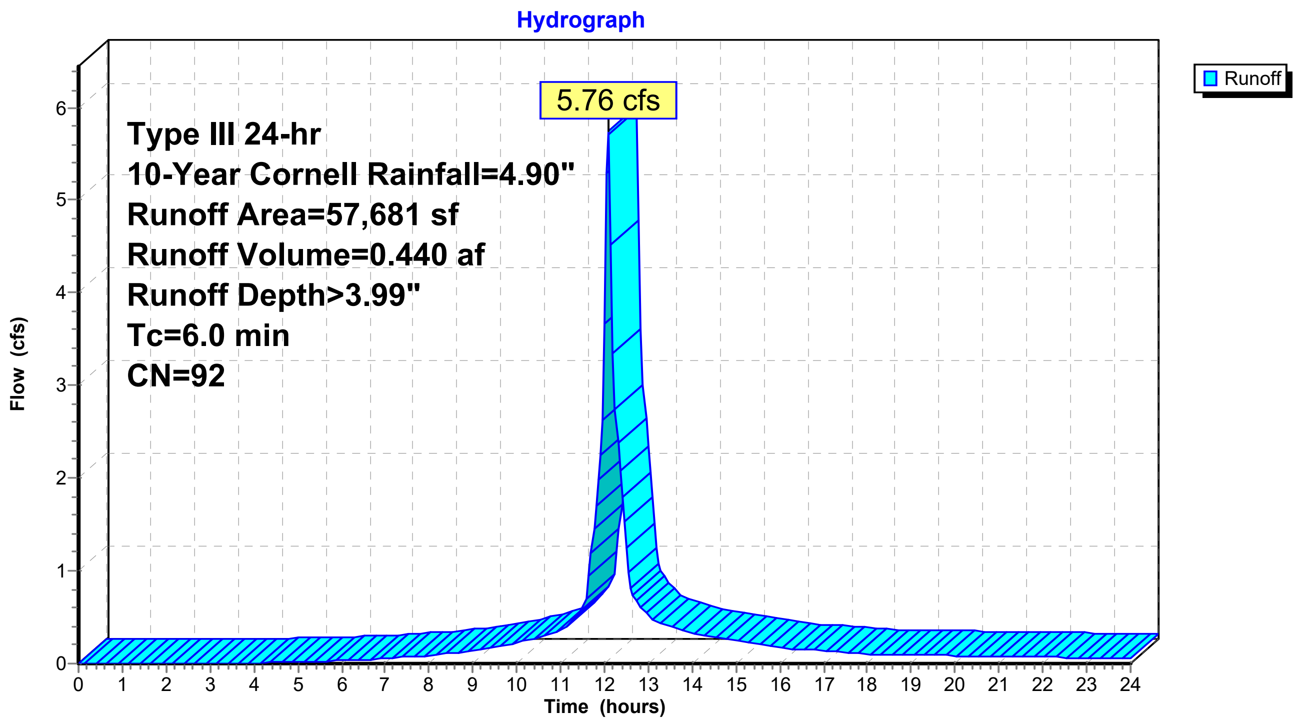
Runoff = 5.76 cfs @ 12.09 hrs, Volume= 0.440 af, Depth> 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

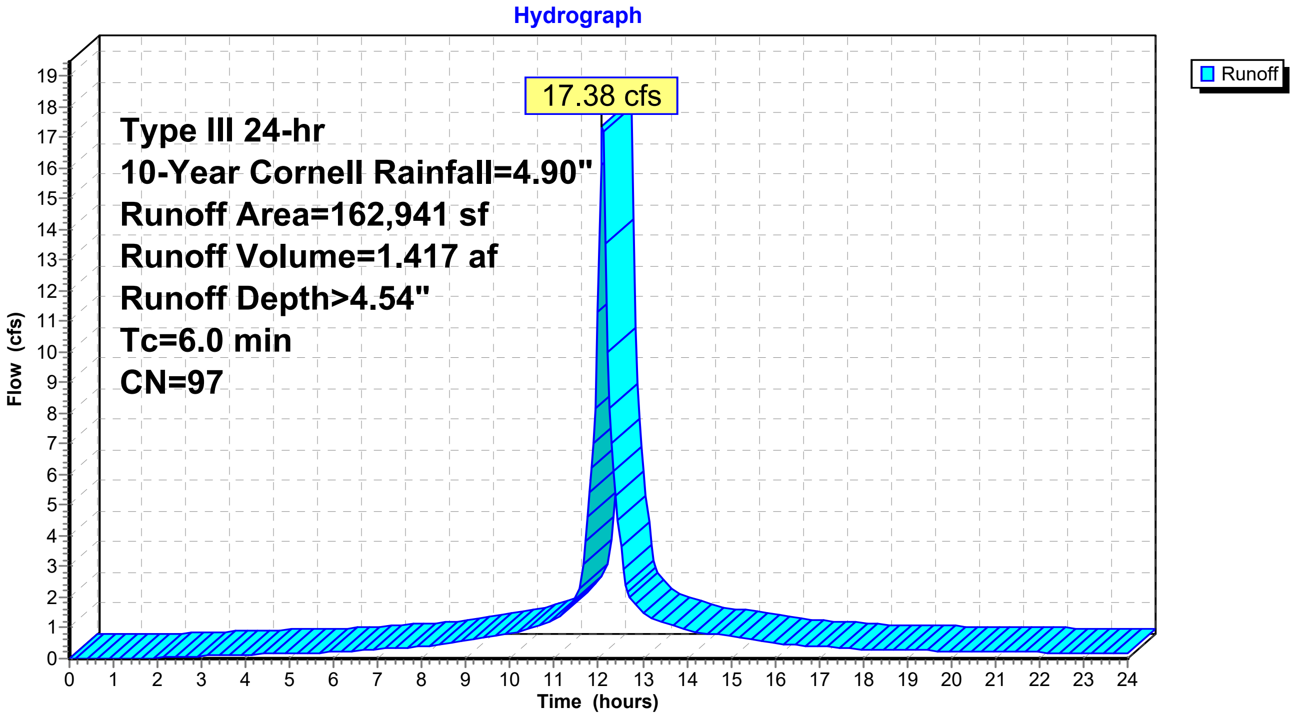
Runoff = 17.38 cfs @ 12.09 hrs, Volume= 1.417 af, Depth> 4.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area = 11.703 ac, 92.70% Impervious, Inflow Depth > 4.28" for 10-Year Cornell event
Inflow = 52.74 cfs @ 12.09 hrs, Volume= 4.176 af
Outflow = 7.69 cfs @ 12.59 hrs, Volume= 4.173 af, Atten= 85%, Lag= 30.4 min
Discarded = 7.69 cfs @ 12.59 hrs, Volume= 4.173 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 18.97' @ 12.59 hrs Surf.Area= 14,652 sf Storage= 63,702 cf

Plug-Flow detention time= 69.2 min calculated for 4.164 af (100% of inflow)
Center-of-Mass det. time= 68.6 min (836.7 - 768.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=7.69 cfs @ 12.59 hrs HW=18.97' (Free Discharge)
└─**2=Exfiltration** (Controls 7.69 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

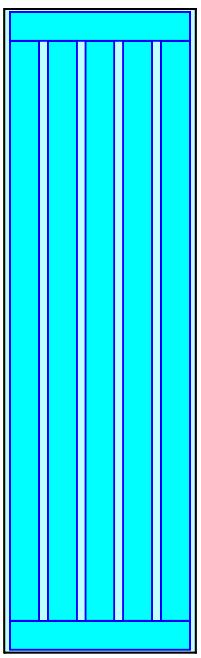
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

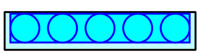
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 = 88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone Storage

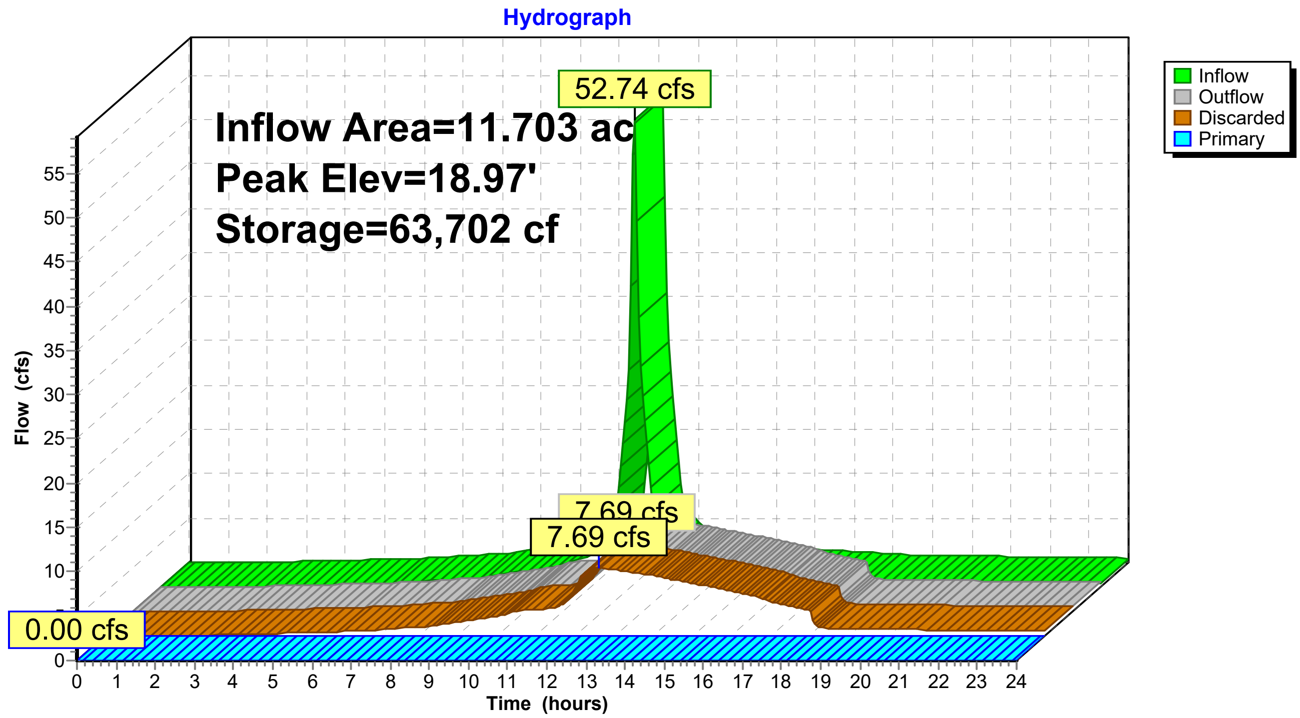
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth > 4.41" for 10-Year Cornell event
Inflow = 24.17 cfs @ 12.09 hrs, Volume= 1.941 af
Outflow = 7.34 cfs @ 12.40 hrs, Volume= 1.470 af, Atten= 70%, Lag= 19.1 min
Discarded = 0.65 cfs @ 12.41 hrs, Volume= 0.789 af
Primary = 6.69 cfs @ 12.40 hrs, Volume= 0.681 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 11.79' @ 12.41 hrs Surf.Area= 14,107 sf Storage= 37,088 cf

Plug-Flow detention time= 180.8 min calculated for 1.467 af (76% of inflow)
Center-of-Mass det. time= 97.7 min (859.6 - 761.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.65 cfs @ 12.41 hrs HW=11.79' (Free Discharge)
└─**3=Exfiltration** (Controls 0.65 cfs)

Primary OutFlow Max=6.68 cfs @ 12.40 hrs HW=11.79' (Free Discharge)
├─**1=Culvert** (Barrel Controls 3.34 cfs @ 3.40 fps)
└─**2=Culvert** (Barrel Controls 3.34 cfs @ 3.40 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

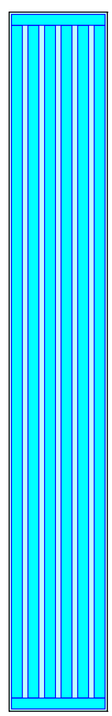
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

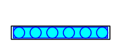
6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 = 37,514.9 cf Chamber Storage

84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

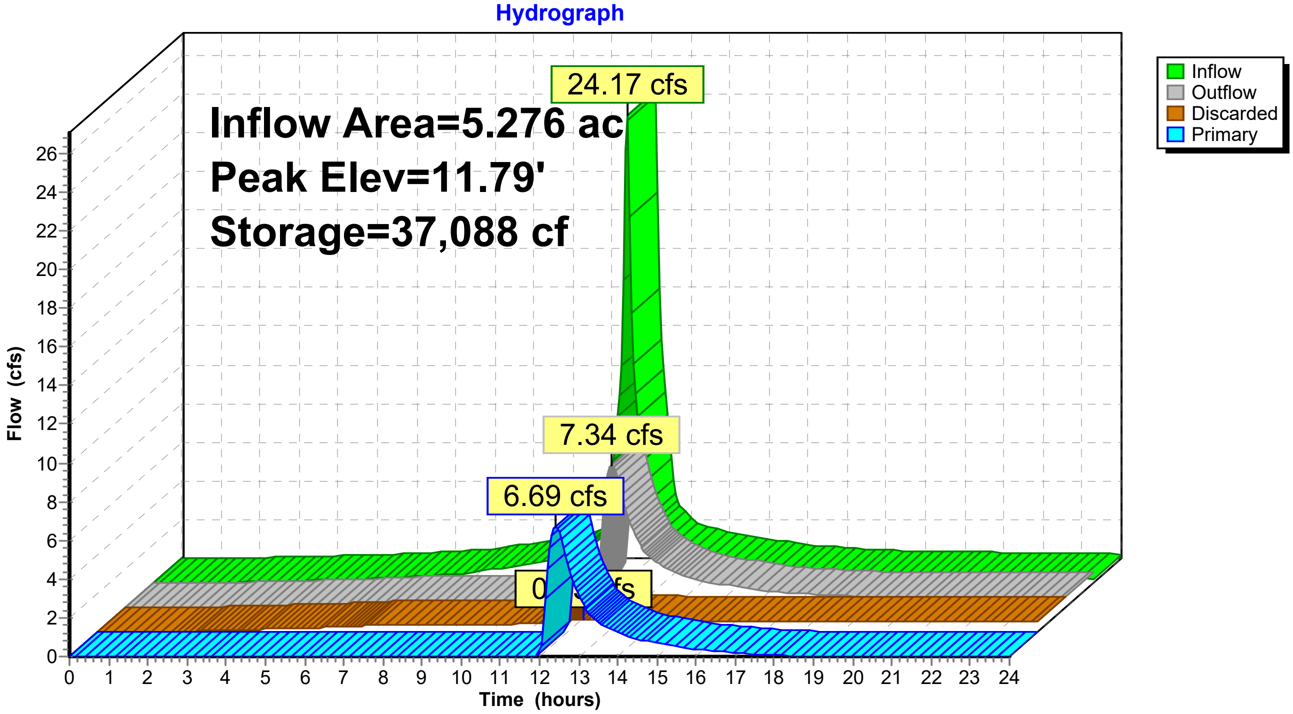
Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone





Pond SSI-2: Subsurface Infiltration System 2

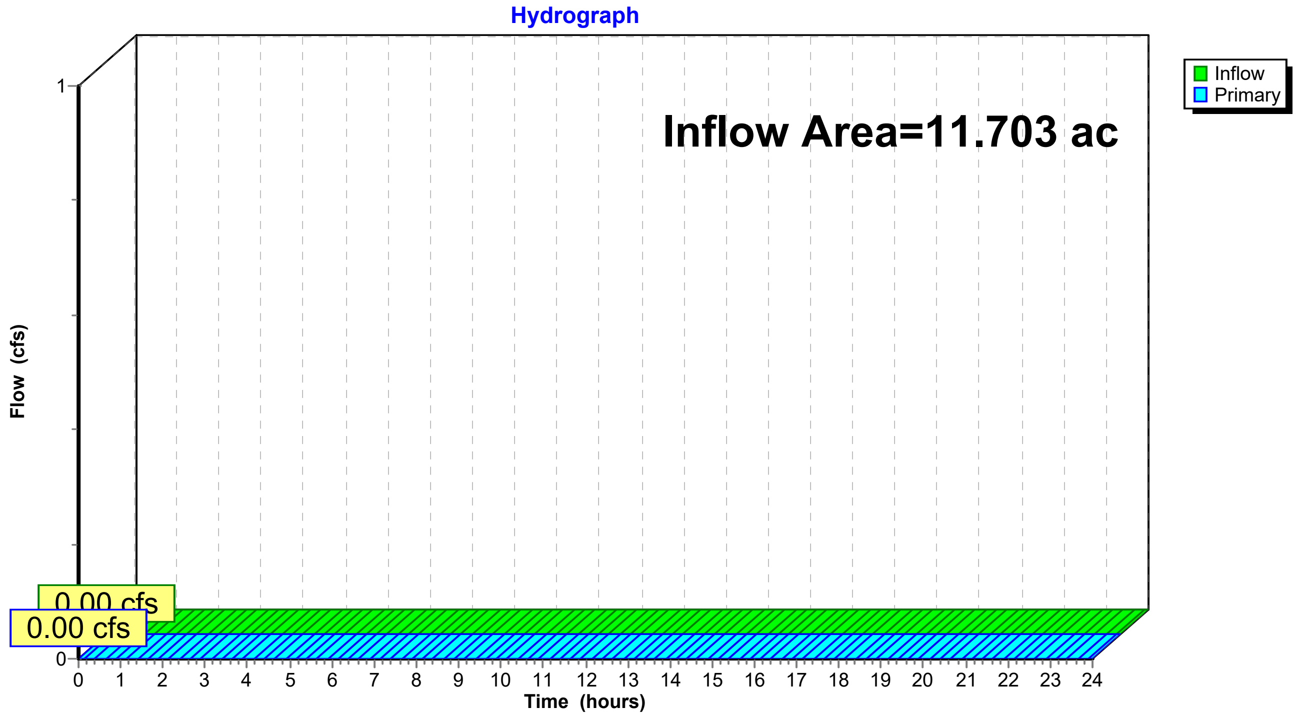


Summary for Link POA-1: 30" Pipe

Inflow Area = 11.703 ac, 92.70% Impervious, Inflow Depth = 0.00" for 10-Year Cornell event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

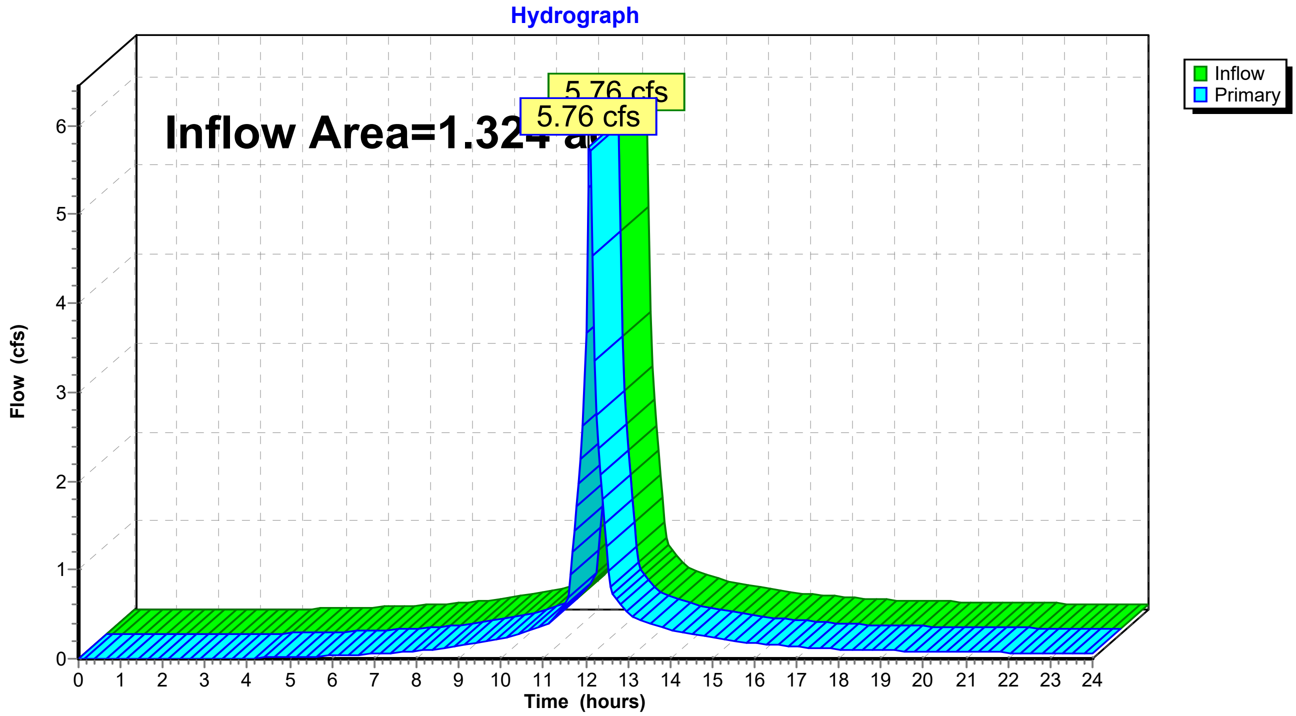


Summary for Link POA-2: 15" Pipe

Inflow Area =	1.324 ac,	83.32% Impervious,	Inflow Depth > 3.99"	for 10-Year Cornell event
Inflow =	5.76 cfs @	12.09 hrs, Volume=	0.440 af	
Primary =	5.76 cfs @	12.09 hrs, Volume=	0.440 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

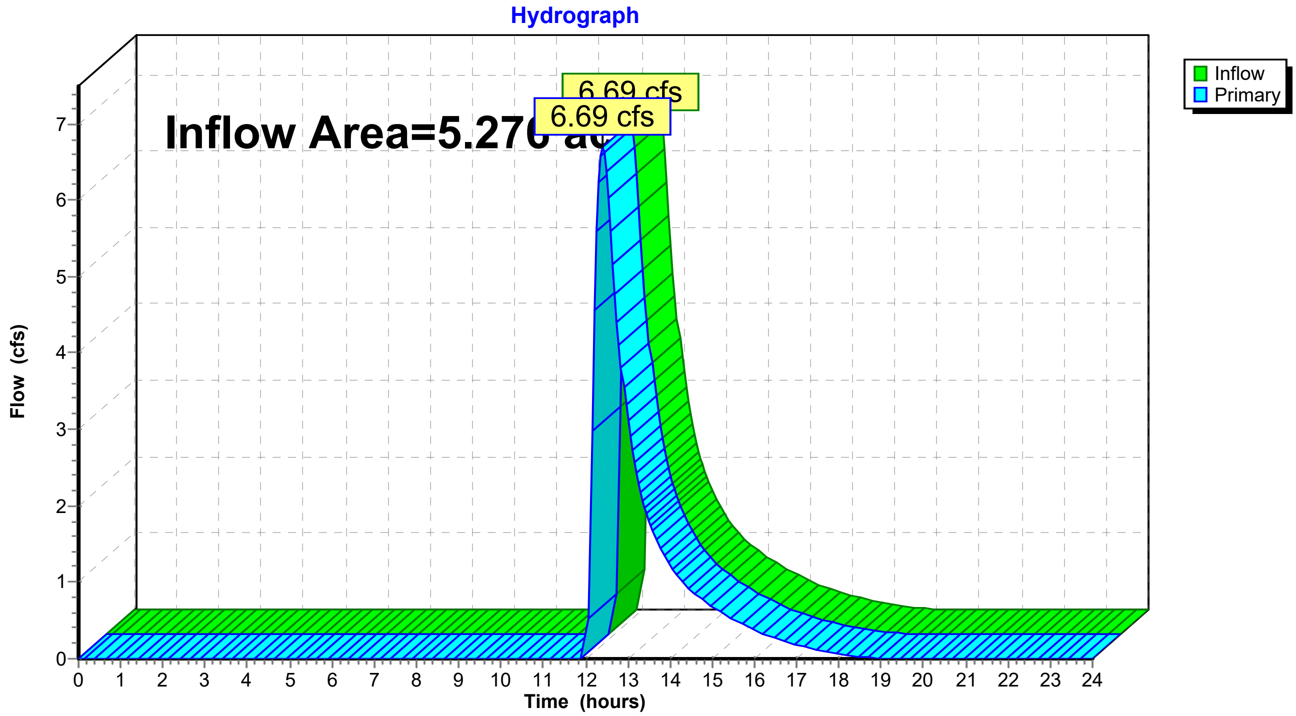


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 1.55" for 10-Year Cornell event
Inflow = 6.69 cfs @ 12.40 hrs, Volume= 0.681 af
Primary = 6.69 cfs @ 12.40 hrs, Volume= 0.681 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>5.38"
Tc=6.0 min CN=93 Runoff=8.77 cfs 0.688 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>5.72"
Tc=6.0 min CN=96 Runoff=53.04 cfs 4.309 af

Subcatchment PR-1B: HVMA Lot Runoff Area=116,176 sf 79.06% Impervious Runoff Depth>5.04"
Tc=6.0 min CN=90 Runoff=14.65 cfs 1.120 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>5.26"
Tc=6.0 min CN=92 Runoff=7.47 cfs 0.581 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>5.84"
Tc=6.0 min CN=97 Runoff=22.09 cfs 1.820 af

Pond SSI-1: Subsurface Infiltration System Peak Elev=20.89' Storage=87,790 cf Inflow=67.68 cfs 5.429 af
Discarded=9.04 cfs 5.425 af Primary=0.00 cfs 0.000 af Outflow=9.04 cfs 5.425 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=12.37' Storage=43,368 cf Inflow=30.86 cfs 2.508 af
Discarded=0.70 cfs 0.838 af Primary=12.74 cfs 1.158 af Outflow=13.44 cfs 1.996 af

Link POA-1: 30" Pipe Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link POA-2: 15" Pipe Inflow=7.47 cfs 0.581 af
Primary=7.47 cfs 0.581 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=12.74 cfs 1.158 af
Primary=12.74 cfs 1.158 af

Total Runoff Area = 18.303 ac Runoff Volume = 8.518 af Average Runoff Depth = 5.58"
7.59% Pervious = 1.390 ac 92.41% Impervious = 16.914 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

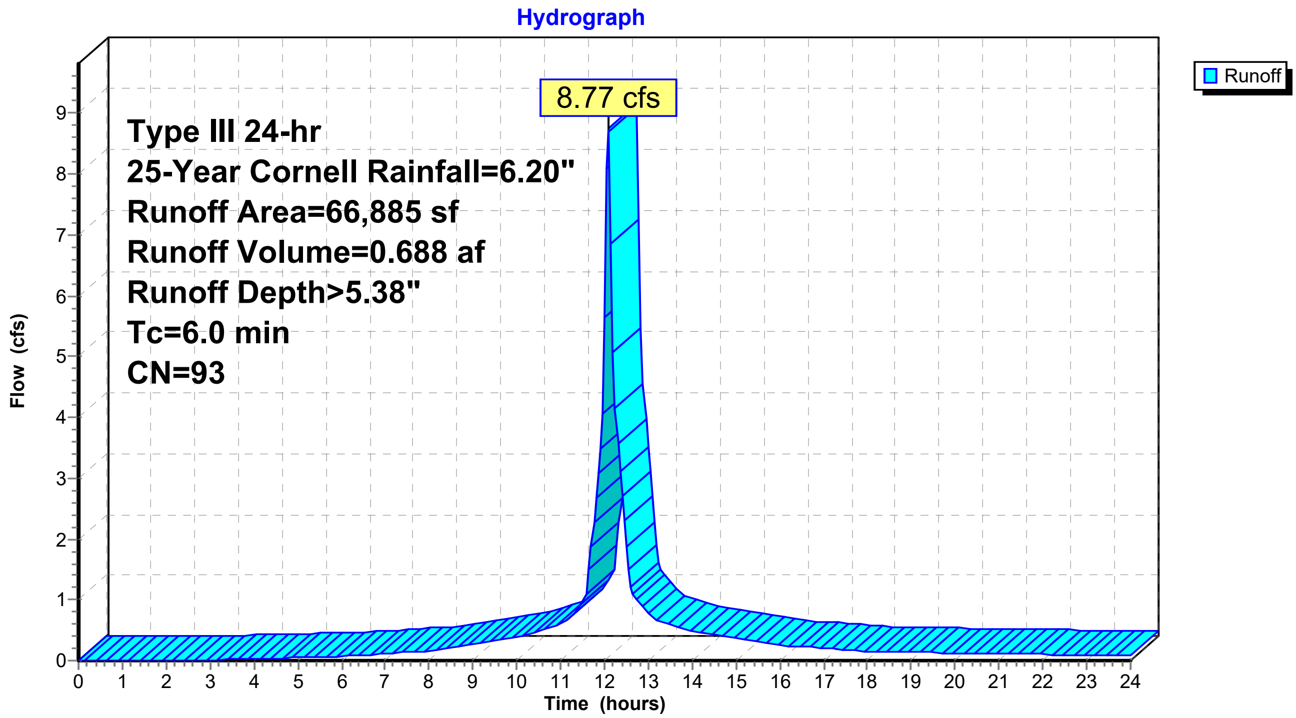
Runoff = 8.77 cfs @ 12.09 hrs, Volume= 0.688 af, Depth> 5.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

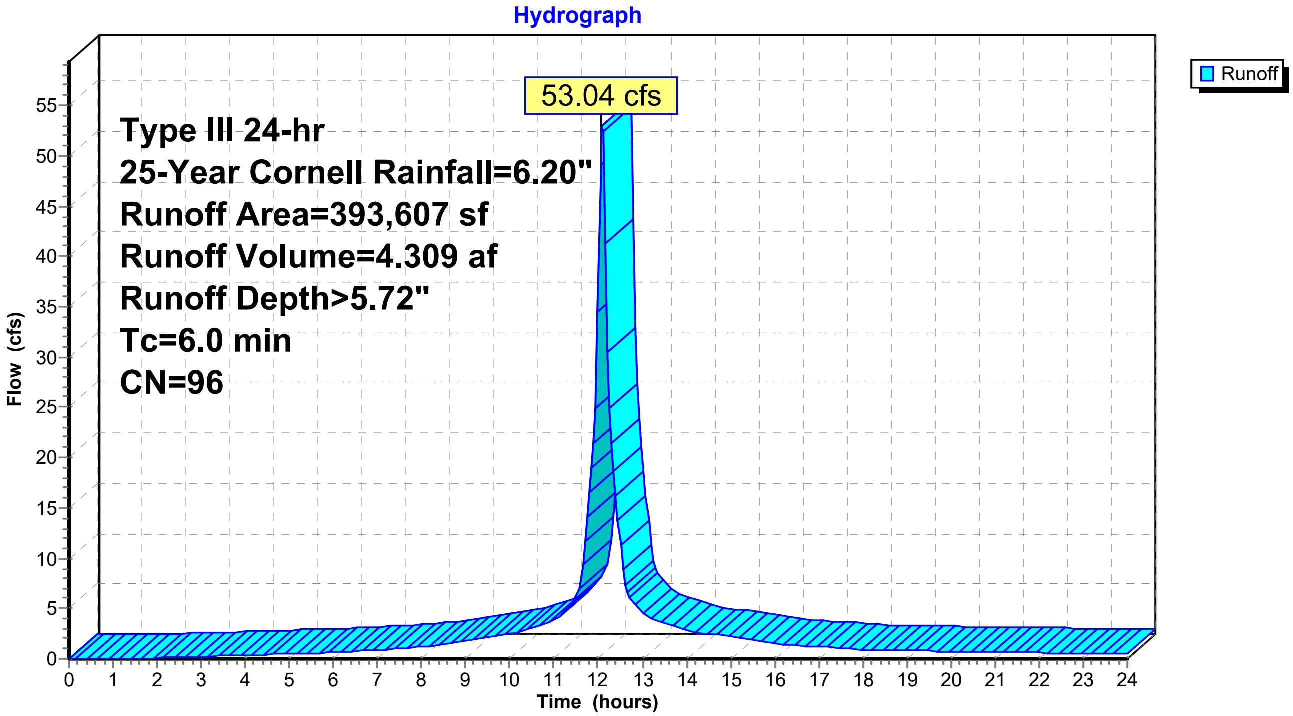
Runoff = 53.04 cfs @ 12.09 hrs, Volume= 4.309 af, Depth> 5.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

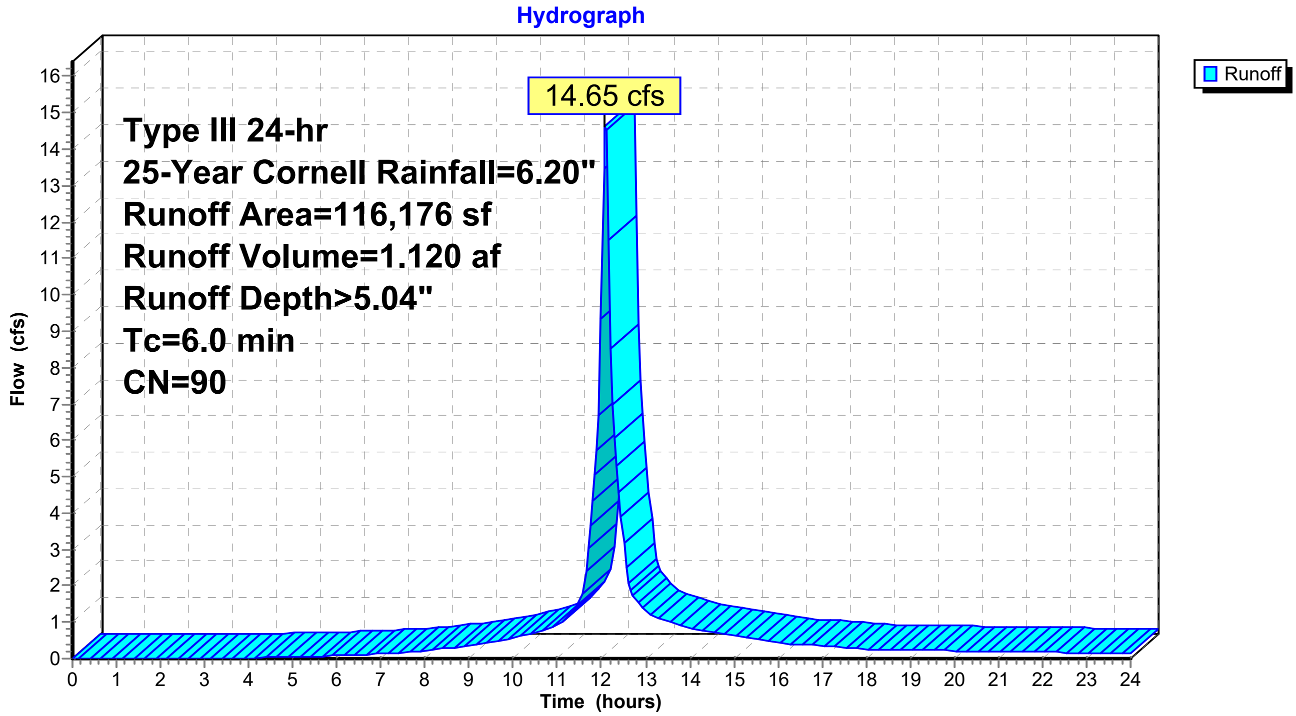
Runoff = 14.65 cfs @ 12.09 hrs, Volume= 1.120 af, Depth> 5.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
24,326	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
73,225	98	Paved parking, HSG B
116,176	90	Weighted Average
24,326		20.94% Pervious Area
91,850		79.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

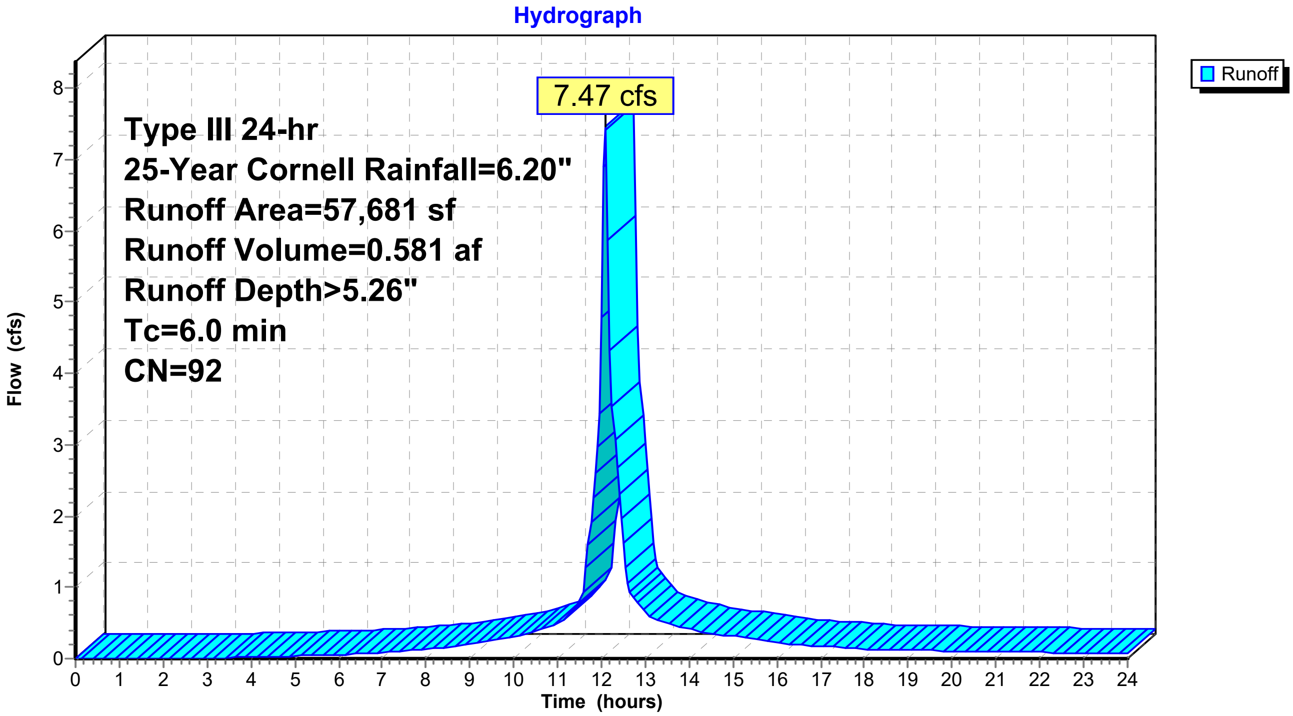
Runoff = 7.47 cfs @ 12.09 hrs, Volume= 0.581 af, Depth> 5.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

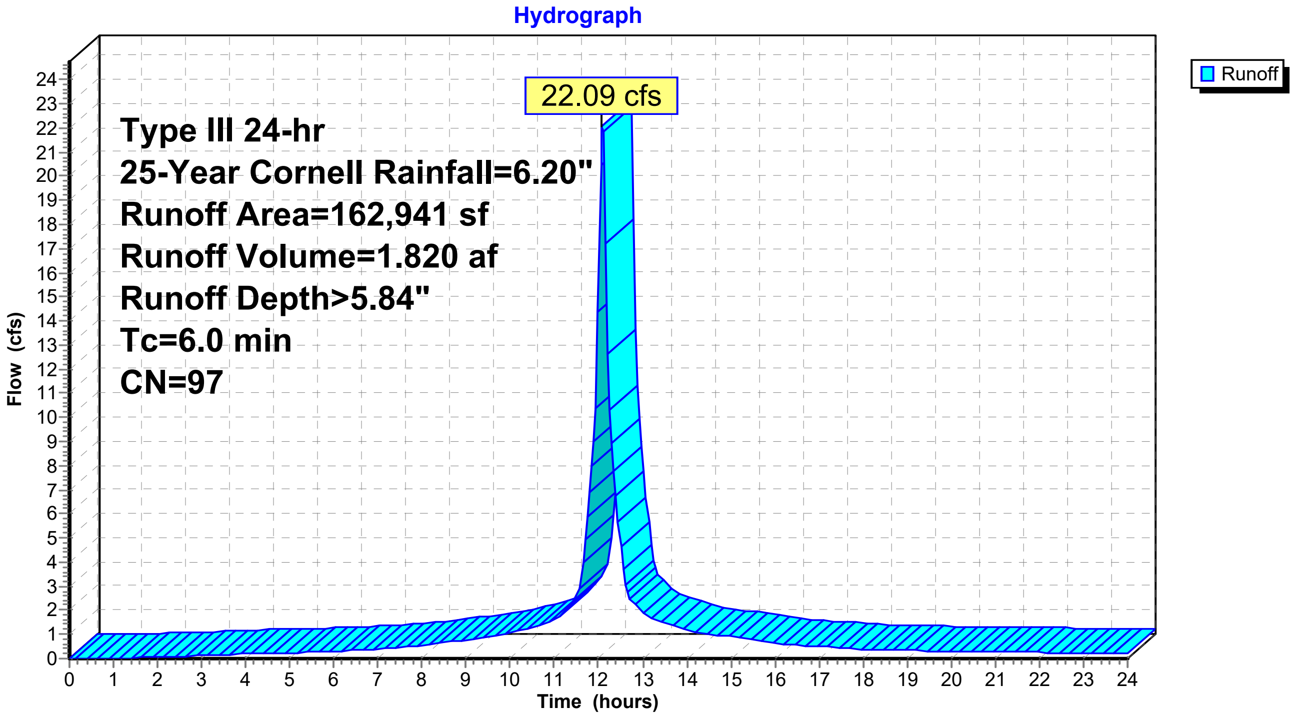
Runoff = 22.09 cfs @ 12.09 hrs, Volume= 1.820 af, Depth> 5.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area =	11.703 ac, 92.70% Impervious, Inflow Depth > 5.57"	for 25-Year Cornell event	
Inflow =	67.68 cfs @ 12.09 hrs, Volume=	5.429 af	
Outflow =	9.04 cfs @ 12.62 hrs, Volume=	5.425 af,	Atten= 87%, Lag= 32.0 min
Discarded =	9.04 cfs @ 12.62 hrs, Volume=	5.425 af	
Primary =	0.00 cfs @ 0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 20.89' @ 12.62 hrs Surf.Area= 14,652 sf Storage= 87,790 cf

Plug-Flow detention time= 86.8 min calculated for 5.414 af (100% of inflow)
Center-of-Mass det. time= 86.1 min (848.6 - 762.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=9.04 cfs @ 12.62 hrs HW=20.89' (Free Discharge)
└─**2=Exfiltration** (Controls 9.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

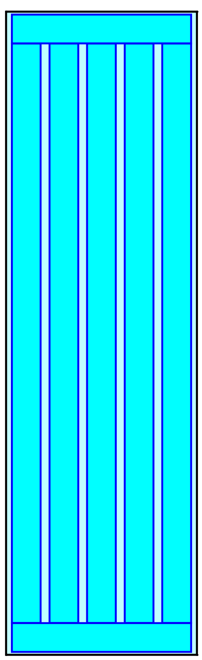
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

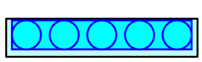
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 =
88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone
Storage

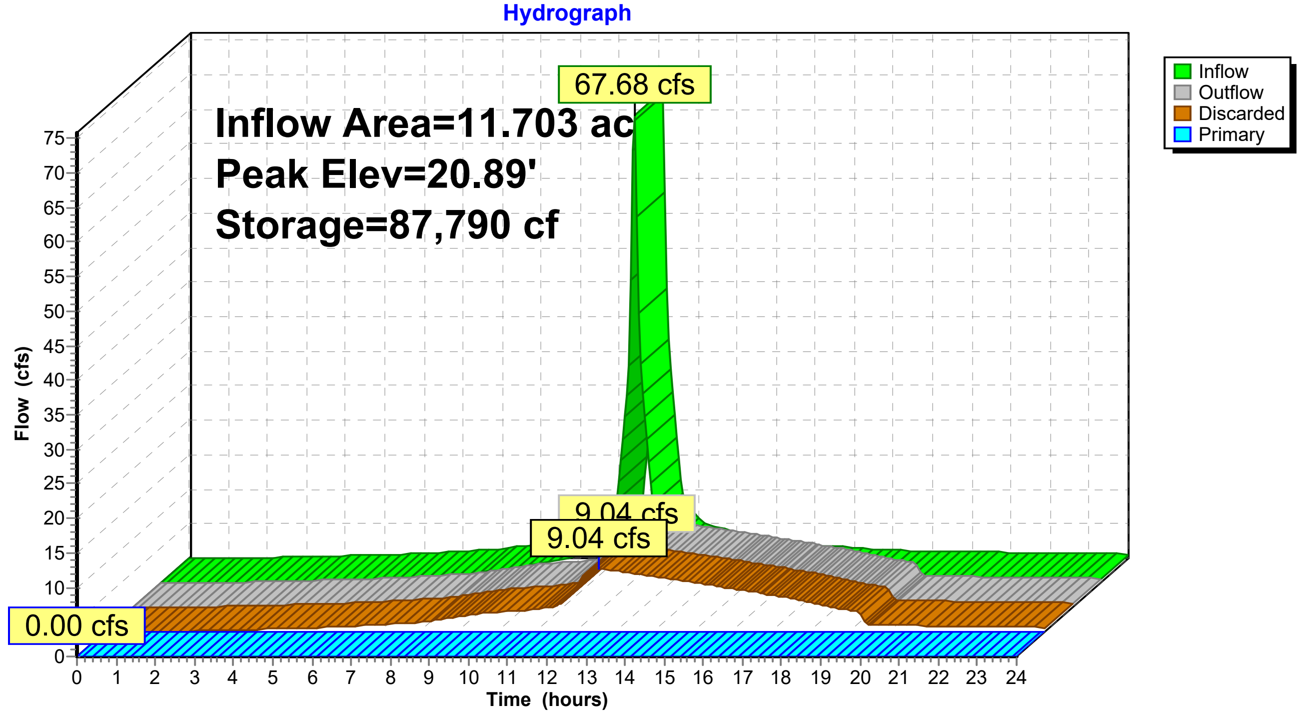
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area =	5.276 ac,	94.04% Impervious,	Inflow Depth > 5.71"	for 25-Year Cornell event
Inflow =	30.86 cfs @	12.09 hrs, Volume=	2.508 af	
Outflow =	13.44 cfs @	12.28 hrs, Volume=	1.996 af,	Atten= 56%, Lag= 11.4 min
Discarded =	0.70 cfs @	12.28 hrs, Volume=	0.838 af	
Primary =	12.74 cfs @	12.28 hrs, Volume=	1.158 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 12.37' @ 12.28 hrs Surf.Area= 14,107 sf Storage= 43,368 cf

Plug-Flow detention time= 152.6 min calculated for 1.991 af (79% of inflow)
Center-of-Mass det. time= 76.5 min (833.2 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.70 cfs @ 12.28 hrs HW=12.37' (Free Discharge)
└─**3=Exfiltration** (Controls 0.70 cfs)

Primary OutFlow Max=12.71 cfs @ 12.28 hrs HW=12.37' (Free Discharge)
├─**1=Culvert** (Barrel Controls 6.35 cfs @ 4.04 fps)
└─**2=Culvert** (Barrel Controls 6.35 cfs @ 4.04 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

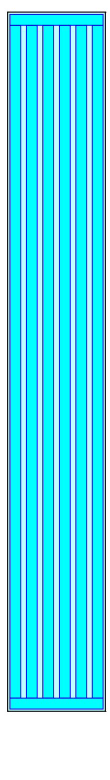
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 =
37,514.9 cf Chamber Storage

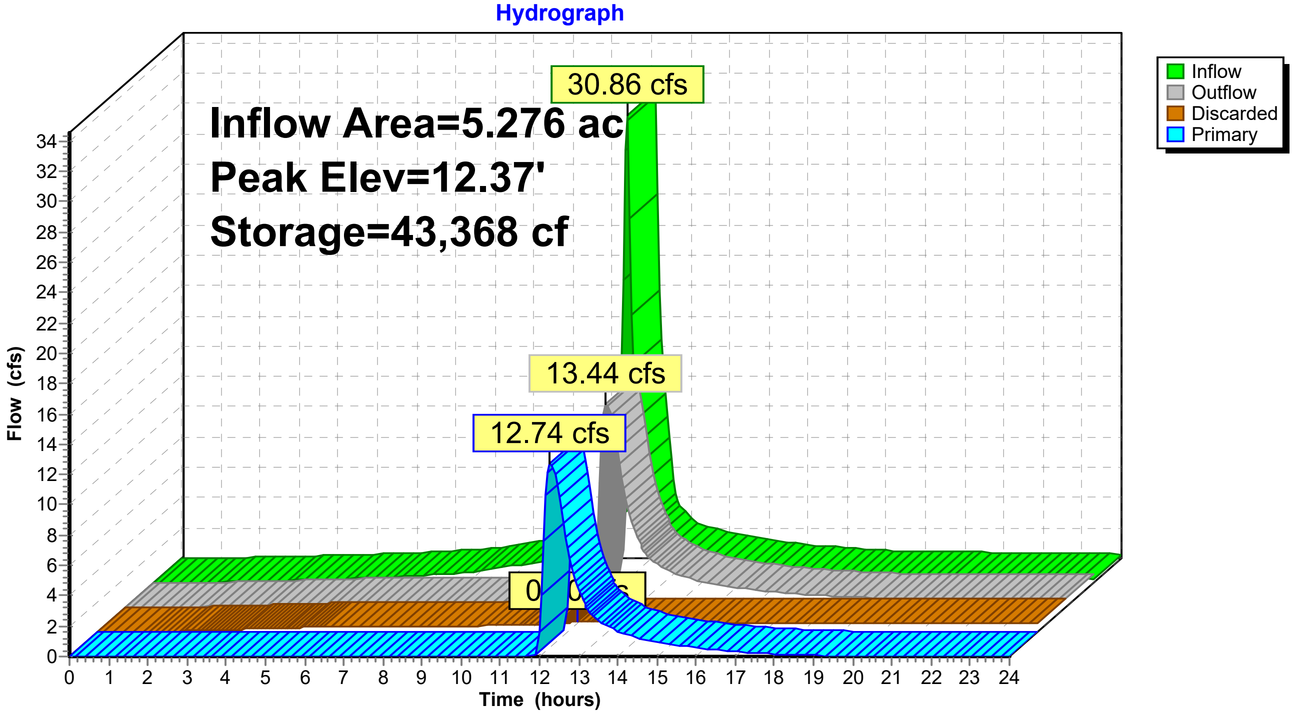
84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone



Pond SSI-2: Subsurface Infiltration System 2

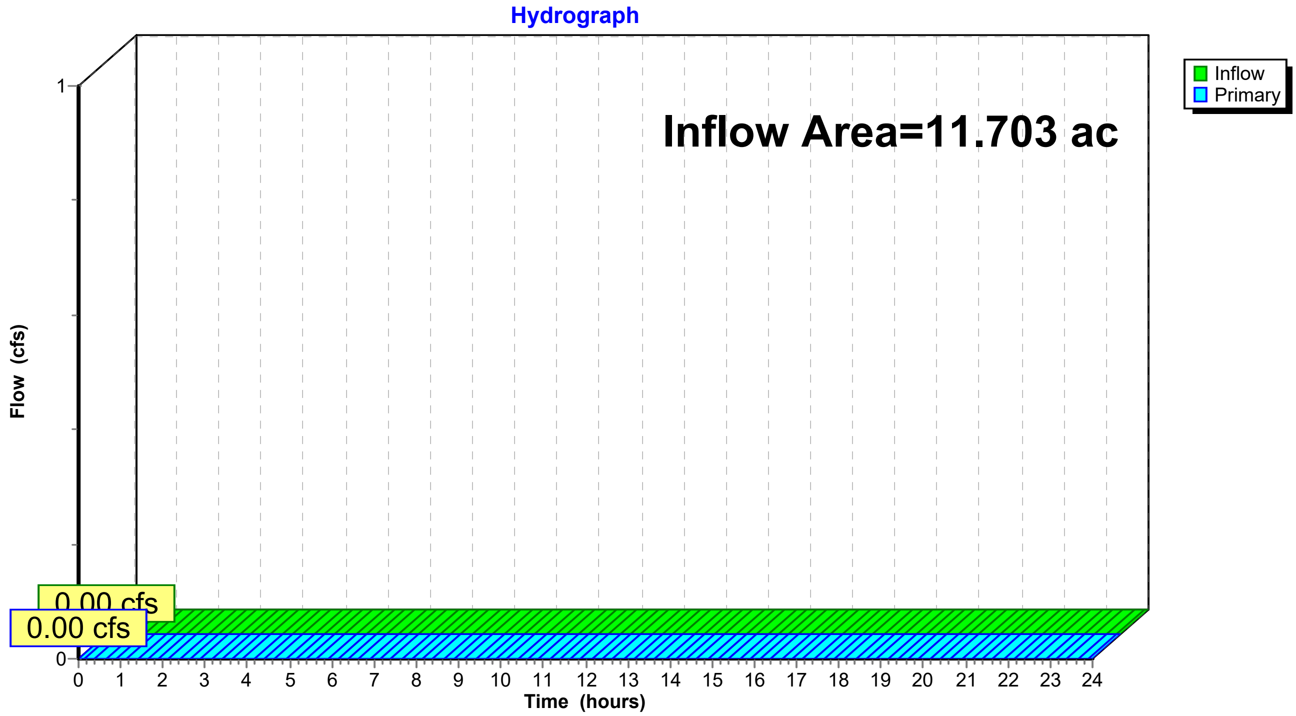


Summary for Link POA-1: 30" Pipe

Inflow Area = 11.703 ac, 92.70% Impervious, Inflow Depth = 0.00" for 25-Year Cornell event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

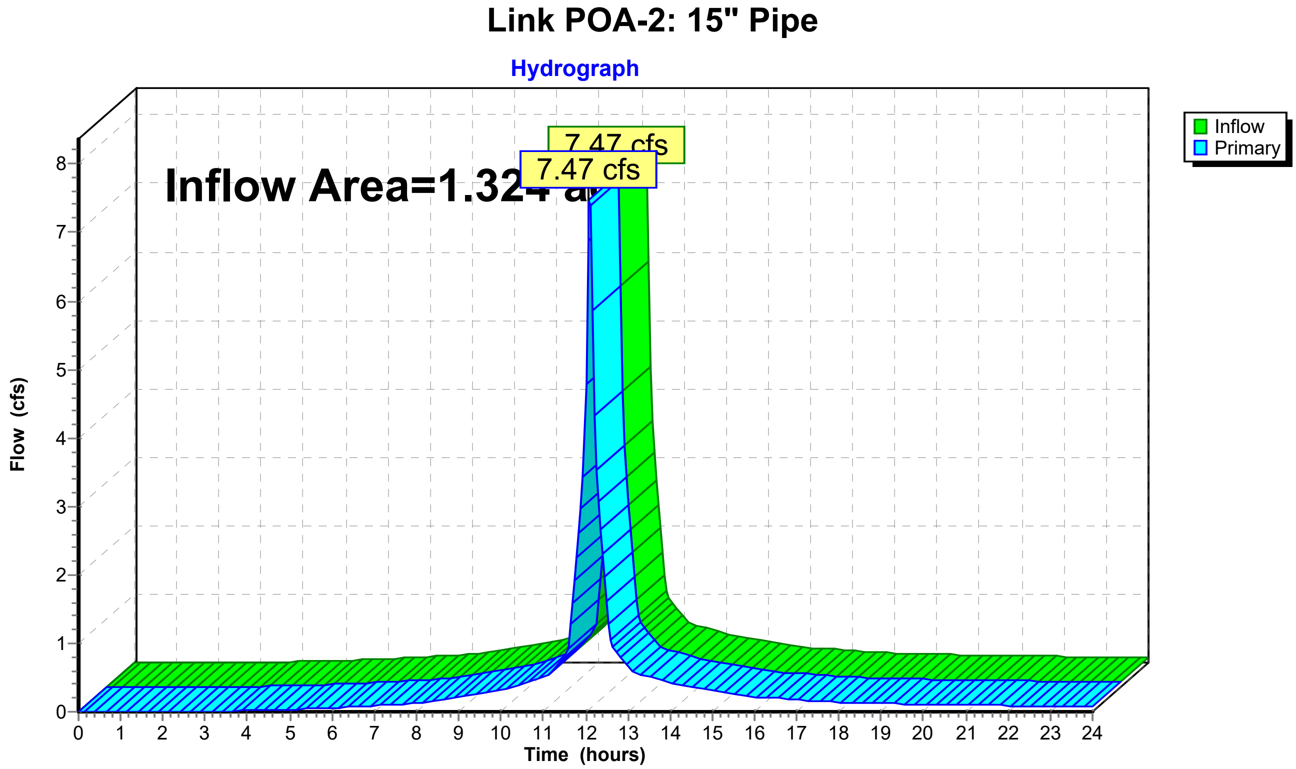
Link POA-1: 30" Pipe



Summary for Link POA-2: 15" Pipe

Inflow Area = 1.324 ac, 83.32% Impervious, Inflow Depth > 5.26" for 25-Year Cornell event
Inflow = 7.47 cfs @ 12.09 hrs, Volume= 0.581 af
Primary = 7.47 cfs @ 12.09 hrs, Volume= 0.581 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

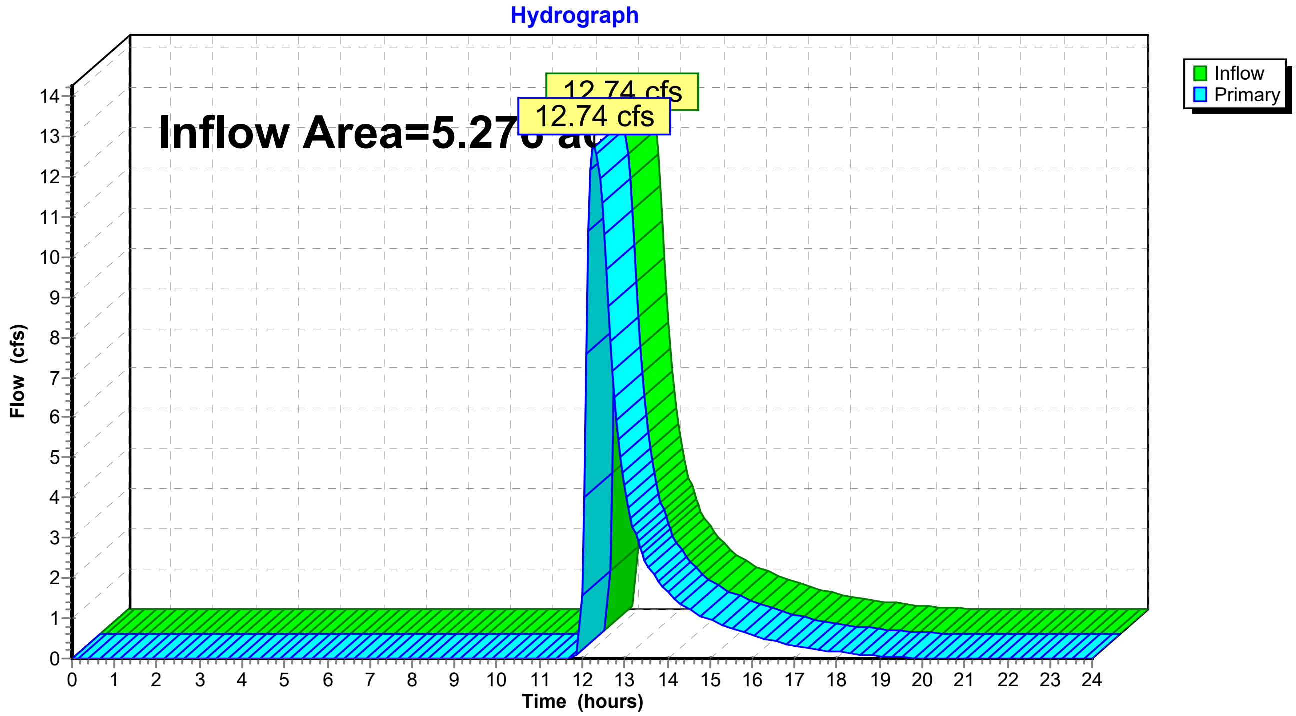


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 2.63" for 25-Year Cornell event
Inflow = 12.74 cfs @ 12.28 hrs, Volume= 1.158 af
Primary = 12.74 cfs @ 12.28 hrs, Volume= 1.158 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>8.05"
Tc=6.0 min CN=93 Runoff=12.84 cfs 1.030 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>8.41"
Tc=6.0 min CN=96 Runoff=76.69 cfs 6.335 af

Subcatchment PR-1B: HVMA Lot Runoff Area=116,176 sf 79.06% Impervious Runoff Depth>7.69"
Tc=6.0 min CN=90 Runoff=21.81 cfs 1.709 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>7.93"
Tc=6.0 min CN=92 Runoff=11.00 cfs 0.875 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>8.53"
Tc=6.0 min CN=97 Runoff=31.85 cfs 2.660 af

Pond SSI-1: Subsurface Infiltration Peak Elev=24.87' Storage=128,323 cf Inflow=98.50 cfs 8.044 af
Discarded=11.83 cfs 7.479 af Primary=13.43 cfs 0.559 af Outflow=25.26 cfs 8.039 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=13.95' Storage=56,105 cf Inflow=44.69 cfs 3.690 af
Discarded=0.83 cfs 0.916 af Primary=21.26 cfs 2.208 af Outflow=22.09 cfs 3.123 af

Link POA-1: 30" Pipe Inflow=13.43 cfs 0.559 af
Primary=13.43 cfs 0.559 af

Link POA-2: 15" Pipe Inflow=11.00 cfs 0.875 af
Primary=11.00 cfs 0.875 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=21.26 cfs 2.208 af
Primary=21.26 cfs 2.208 af

Total Runoff Area = 18.303 ac Runoff Volume = 12.610 af Average Runoff Depth = 8.27"
7.59% Pervious = 1.390 ac 92.41% Impervious = 16.914 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

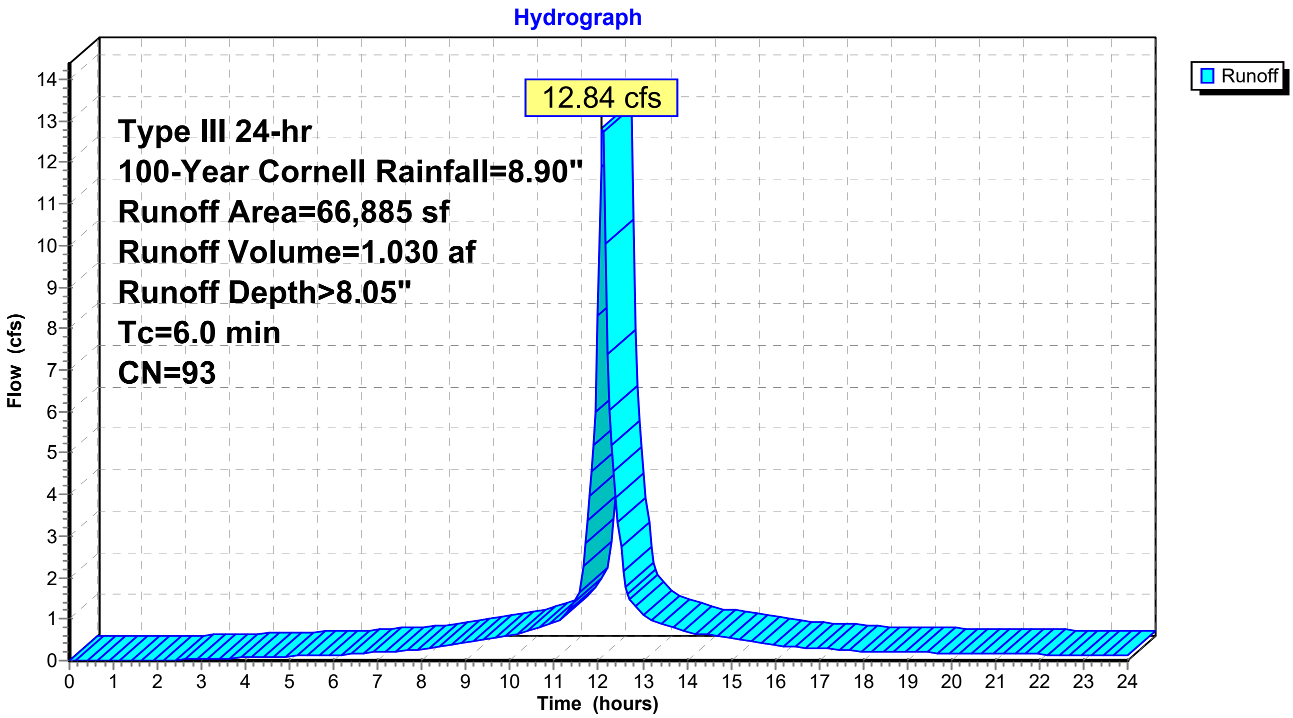
Runoff = 12.84 cfs @ 12.09 hrs, Volume= 1.030 af, Depth> 8.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

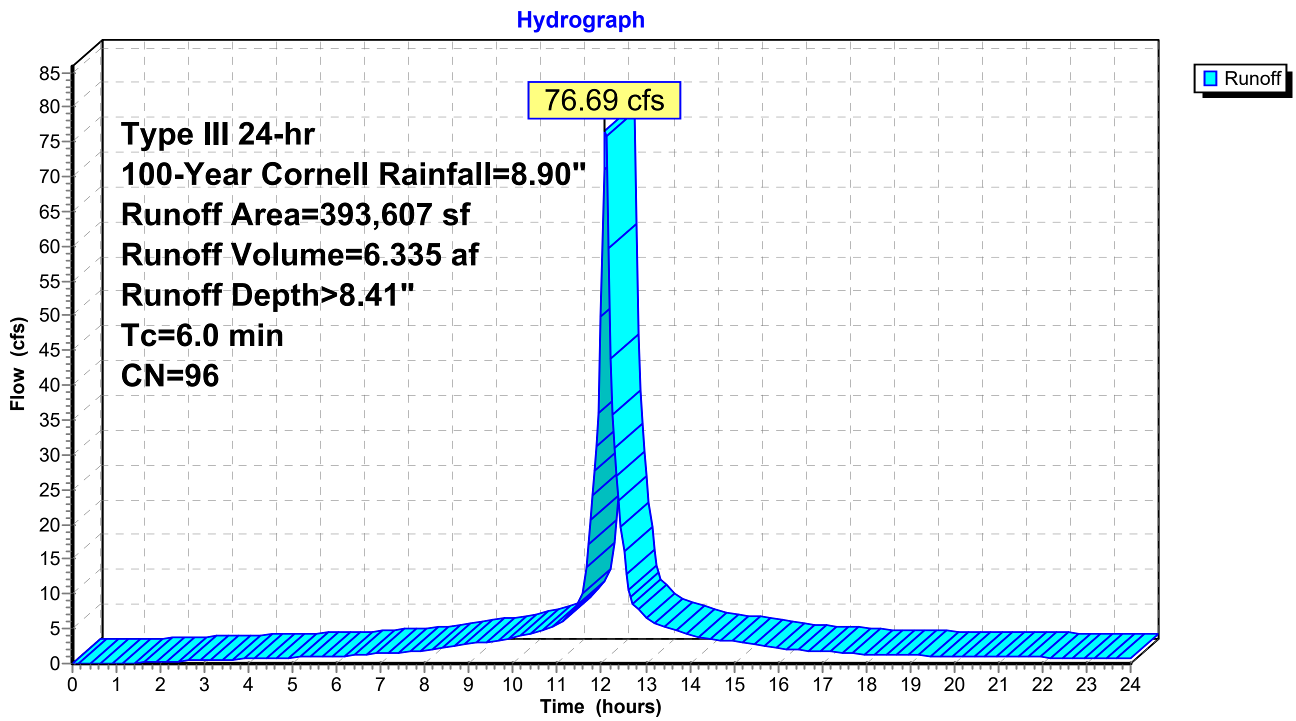
Runoff = 76.69 cfs @ 12.09 hrs, Volume= 6.335 af, Depth> 8.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

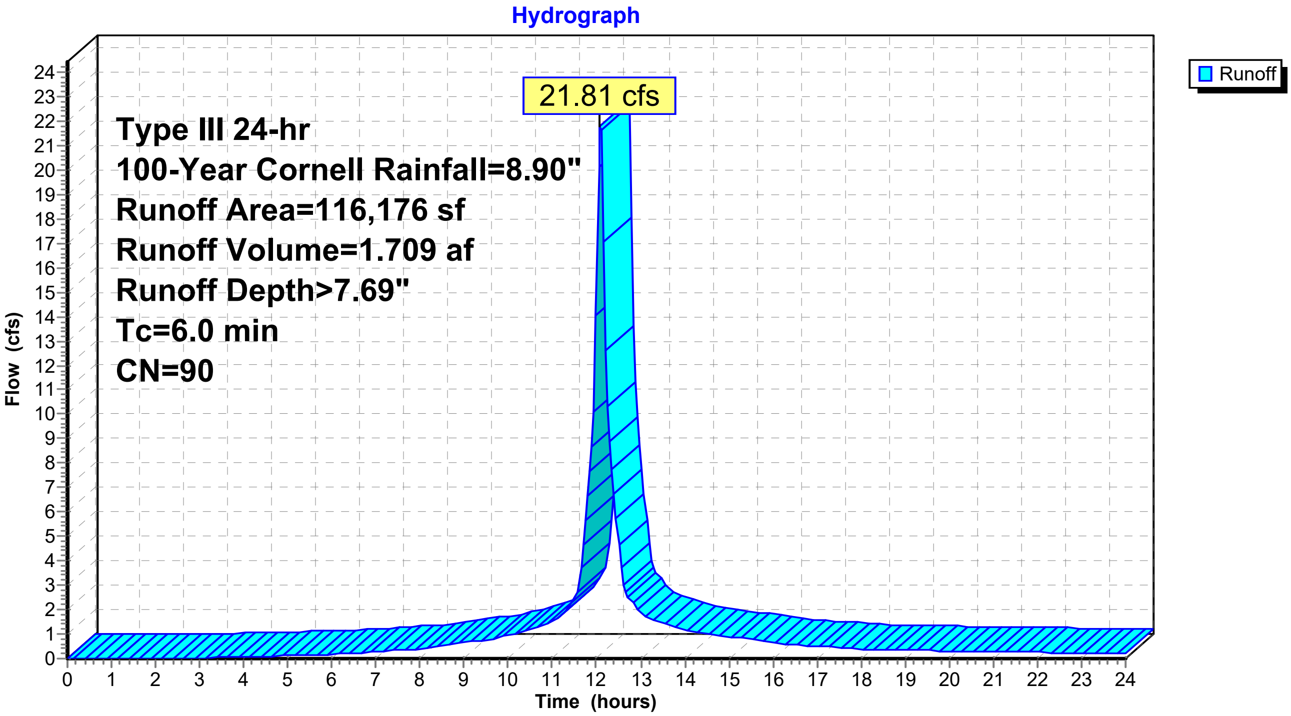
Runoff = 21.81 cfs @ 12.09 hrs, Volume= 1.709 af, Depth> 7.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
24,326	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
73,225	98	Paved parking, HSG B
116,176	90	Weighted Average
24,326		20.94% Pervious Area
91,850		79.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

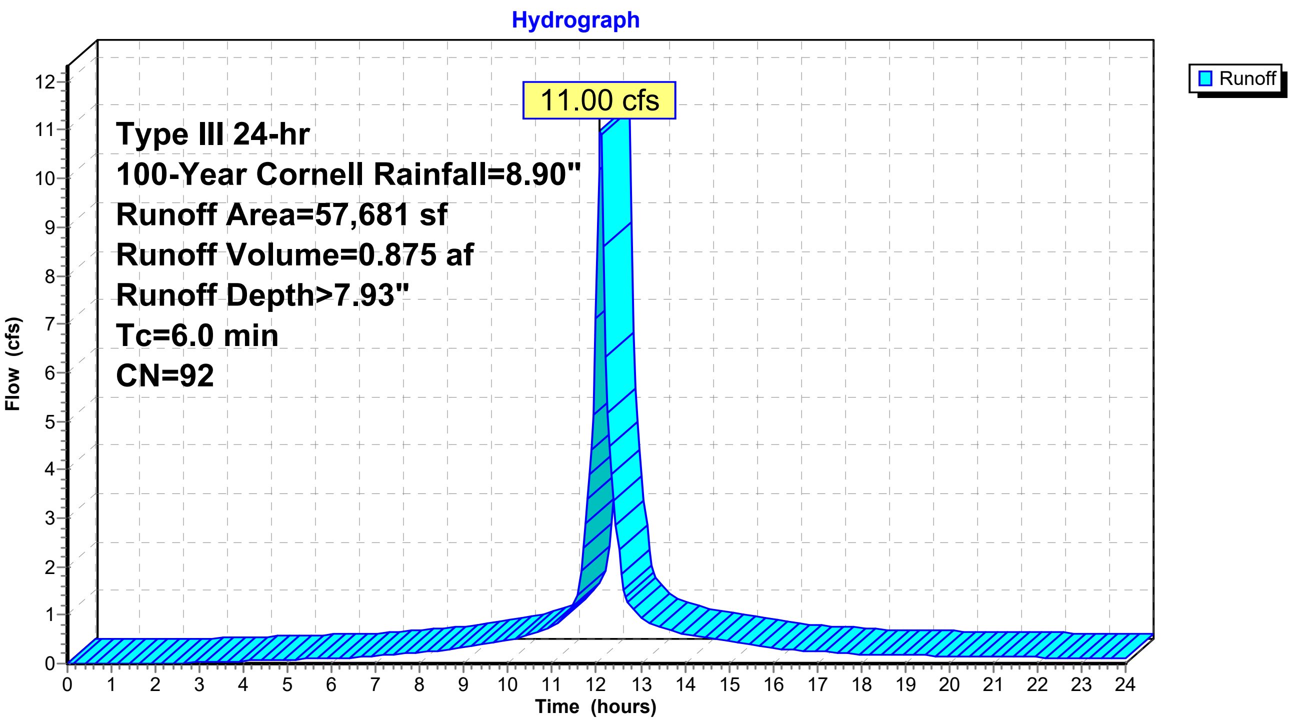
Runoff = 11.00 cfs @ 12.09 hrs, Volume= 0.875 af, Depth> 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

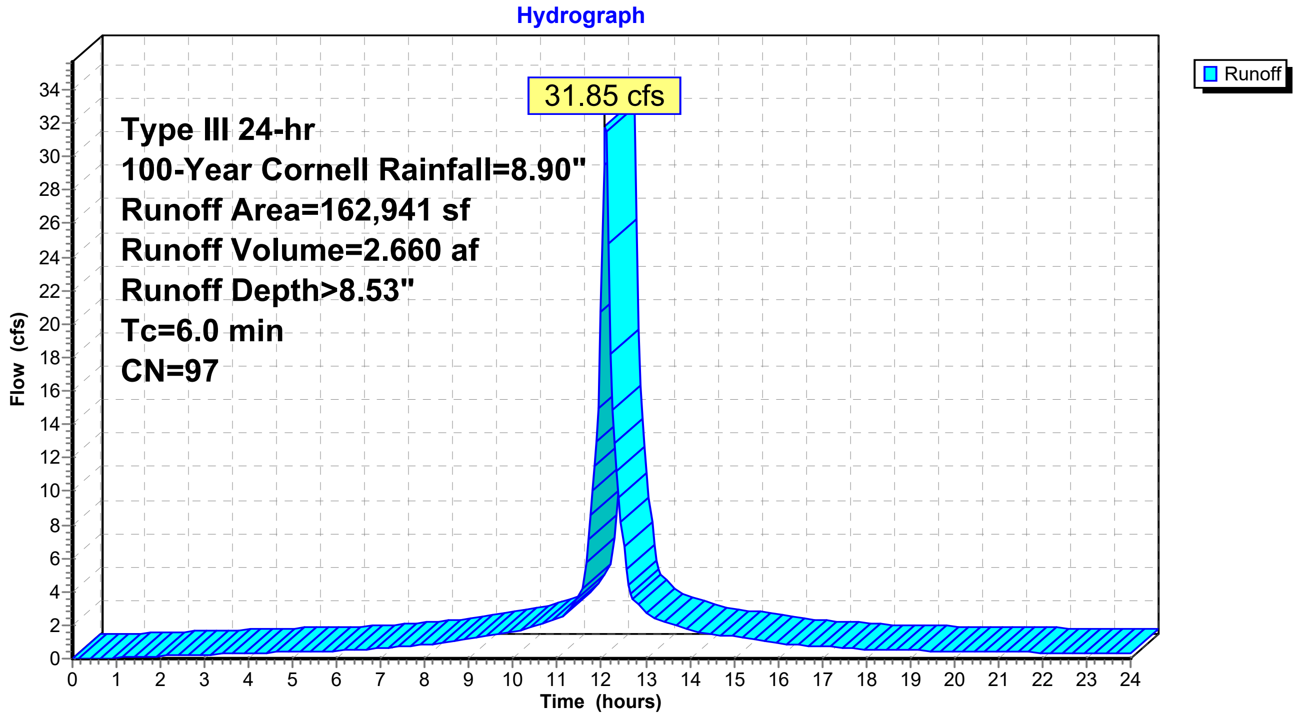
Runoff = 31.85 cfs @ 12.09 hrs, Volume= 2.660 af, Depth> 8.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area =	11.703 ac, 92.70% Impervious, Inflow Depth > 8.25" for 100-Year Cornell event		
Inflow =	98.50 cfs @ 12.09 hrs, Volume=	8.044 af	
Outflow =	25.26 cfs @ 12.46 hrs, Volume=	8.039 af,	Atten= 74%, Lag= 22.1 min
Discarded =	11.83 cfs @ 12.46 hrs, Volume=	7.479 af	
Primary =	13.43 cfs @ 12.46 hrs, Volume=	0.559 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 24.87' @ 12.46 hrs Surf.Area= 14,652 sf Storage= 128,323 cf

Plug-Flow detention time= 98.7 min calculated for 8.022 af (100% of inflow)
Center-of-Mass det. time= 98.0 min (852.7 - 754.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=11.83 cfs @ 12.46 hrs HW=24.86' (Free Discharge)
└─**2=Exfiltration** (Controls 11.83 cfs)

Primary OutFlow Max=13.39 cfs @ 12.46 hrs HW=24.86' (Free Discharge)
└─**1=Culvert** (Barrel Controls 13.39 cfs @ 4.55 fps)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

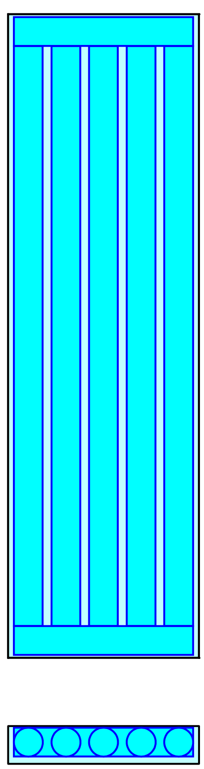
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 = 88,149.7 cf Chamber Storage

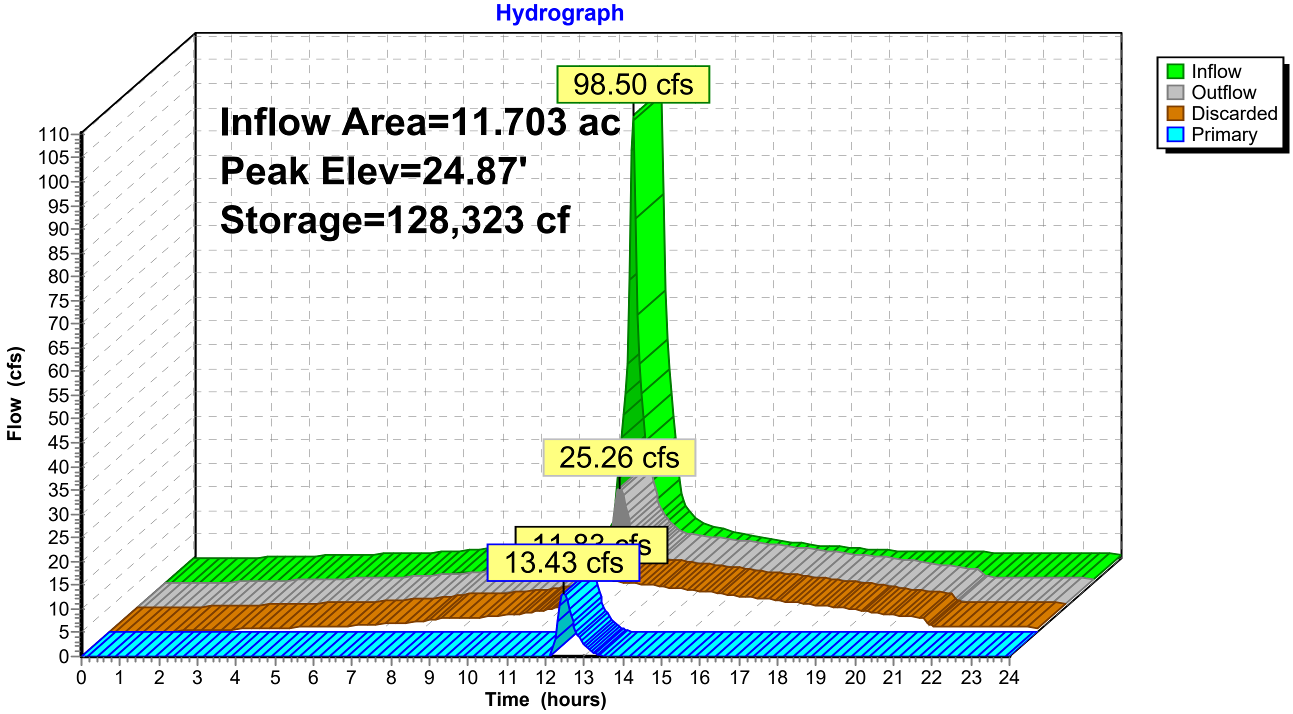
190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone Storage

Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone



Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area =	5.276 ac,	94.04% Impervious,	Inflow Depth > 8.39"	for 100-Year Cornell event
Inflow =	44.69 cfs @	12.09 hrs, Volume=	3.690 af	
Outflow =	22.09 cfs @	12.24 hrs, Volume=	3.123 af,	Atten= 51%, Lag= 9.3 min
Discarded =	0.83 cfs @	12.24 hrs, Volume=	0.916 af	
Primary =	21.26 cfs @	12.24 hrs, Volume=	2.208 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 13.95' @ 12.24 hrs Surf.Area= 14,107 sf Storage= 56,105 cf

Plug-Flow detention time= 126.5 min calculated for 3.117 af (84% of inflow)
Center-of-Mass det. time= 61.6 min (811.5 - 749.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.83 cfs @ 12.24 hrs HW=13.95' (Free Discharge)
└─**3=Exfiltration** (Controls 0.83 cfs)

Primary OutFlow Max=21.23 cfs @ 12.24 hrs HW=13.95' (Free Discharge)
├─**1=Culvert** (Inlet Controls 10.61 cfs @ 6.01 fps)
└─**2=Culvert** (Inlet Controls 10.61 cfs @ 6.01 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

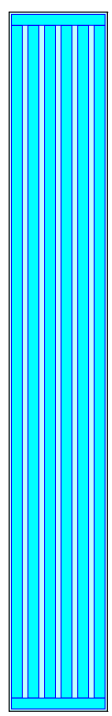
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

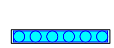
6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 = 37,514.9 cf Chamber Storage

84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

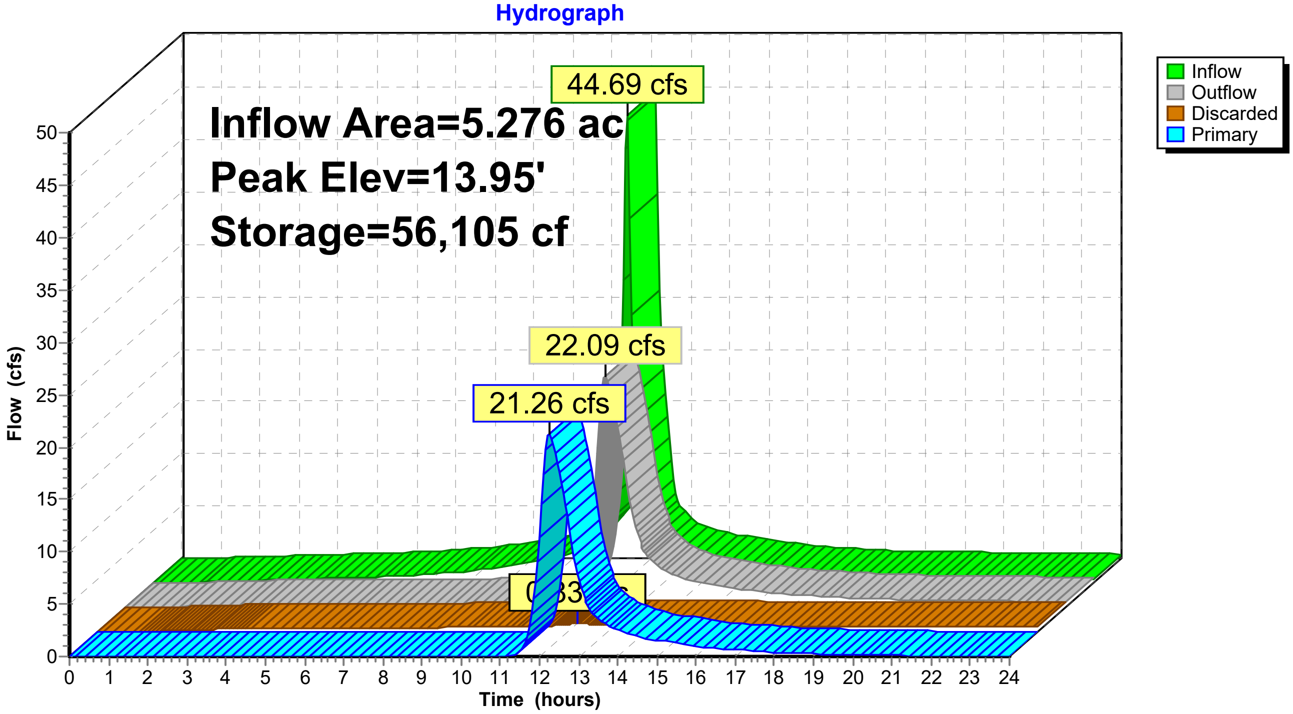
Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone





Pond SSI-2: Subsurface Infiltration System 2

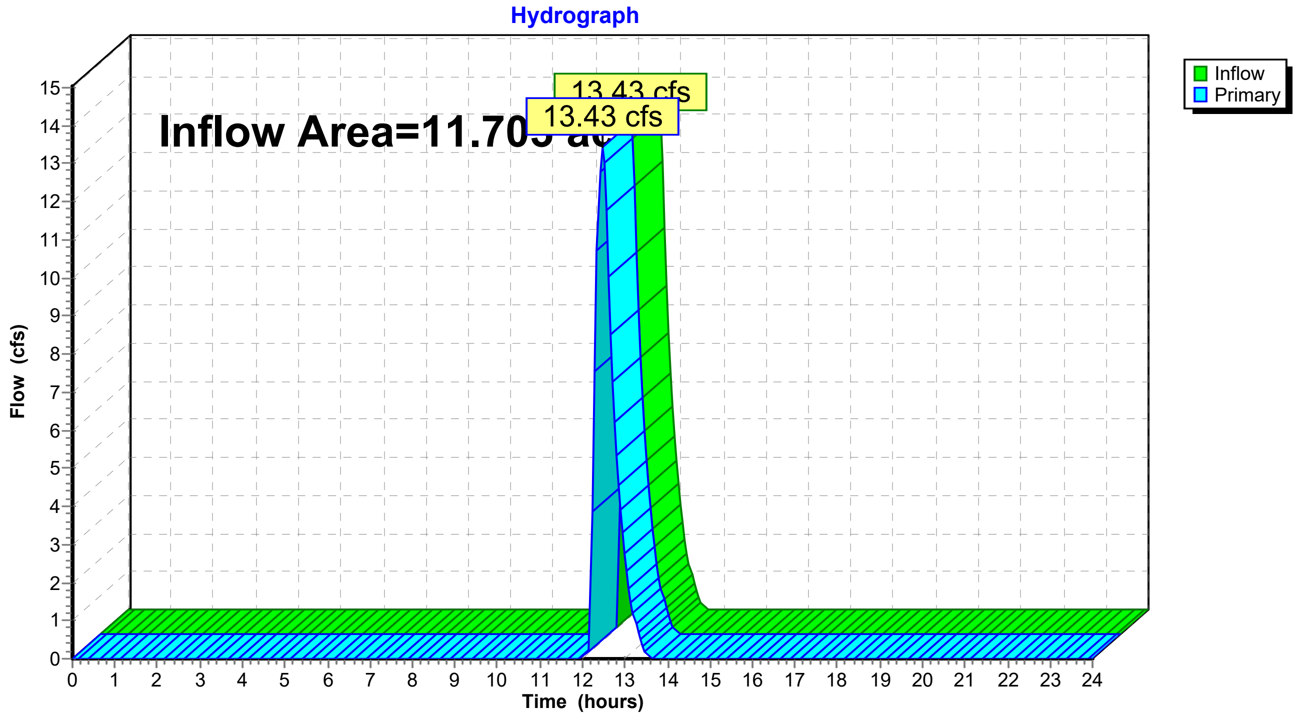


Summary for Link POA-1: 30" Pipe

Inflow Area =	11.703 ac,	92.70% Impervious,	Inflow Depth = 0.57"	for 100-Year Cornell event
Inflow =	13.43 cfs @	12.46 hrs,	Volume=	0.559 af
Primary =	13.43 cfs @	12.46 hrs,	Volume=	0.559 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

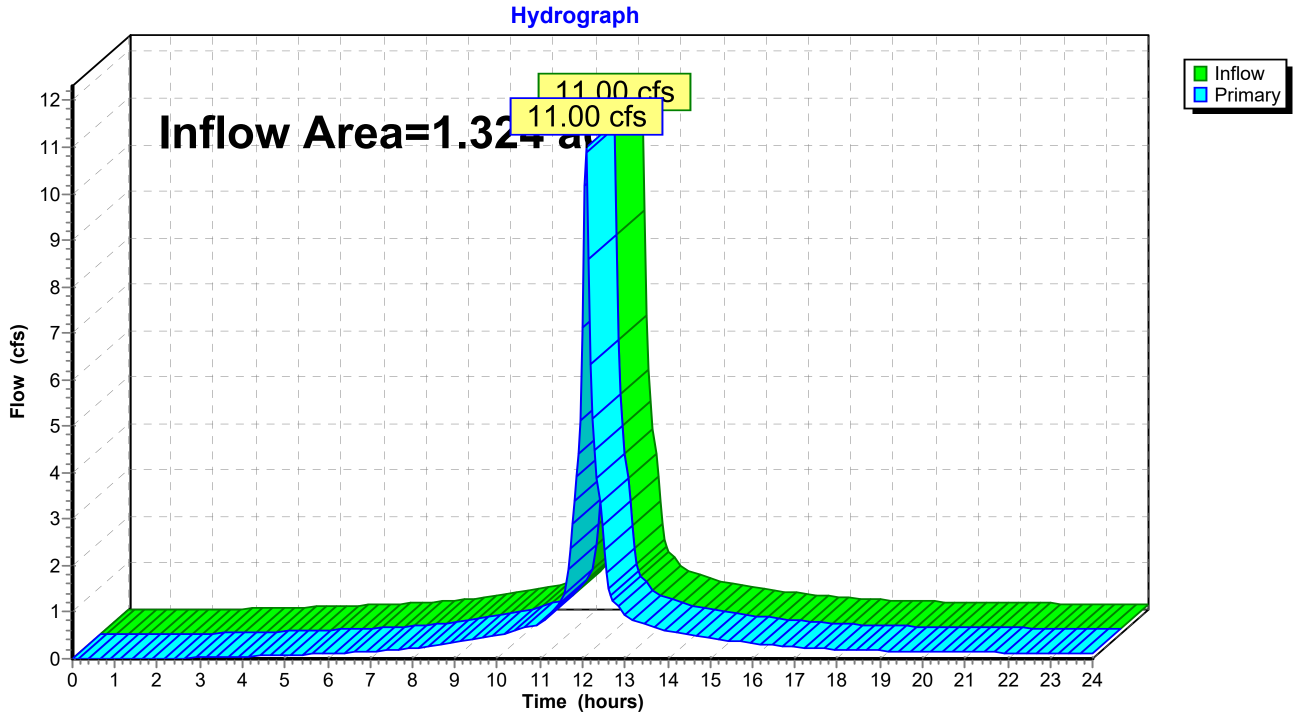


Summary for Link POA-2: 15" Pipe

Inflow Area = 1.324 ac, 83.32% Impervious, Inflow Depth > 7.93" for 100-Year Cornell event
Inflow = 11.00 cfs @ 12.09 hrs, Volume= 0.875 af
Primary = 11.00 cfs @ 12.09 hrs, Volume= 0.875 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

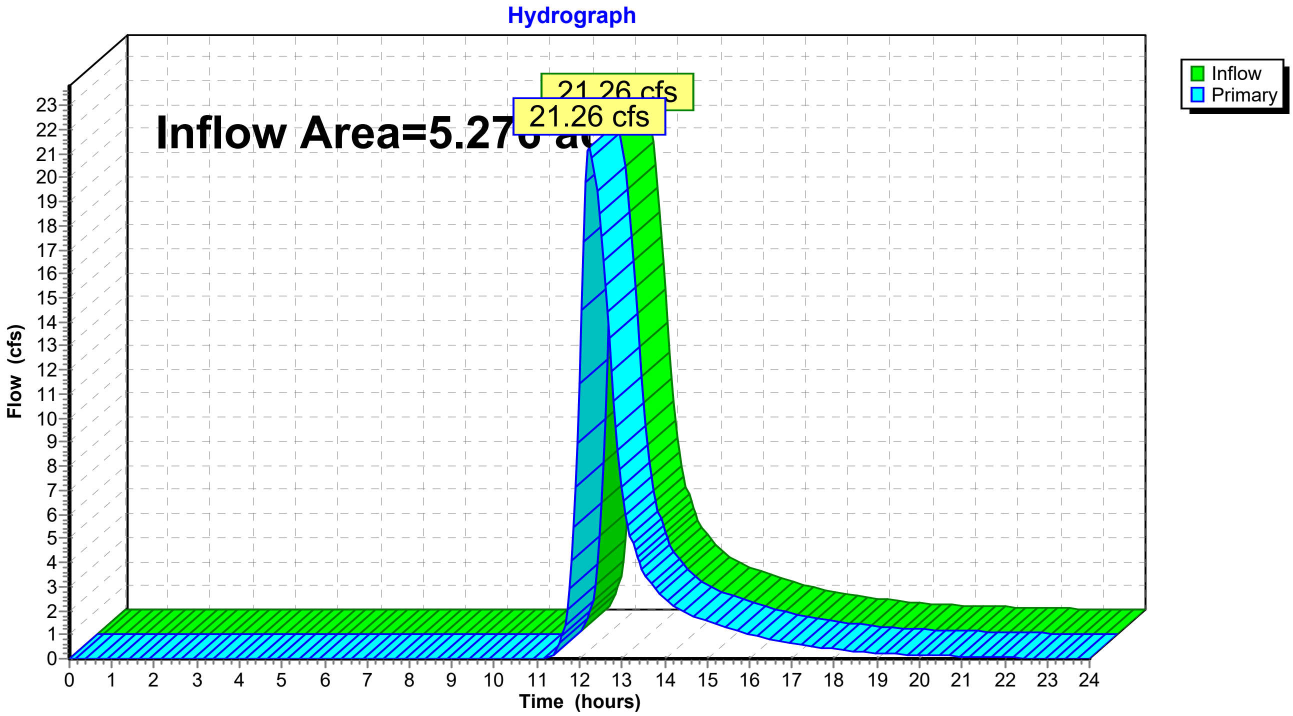


Summary for Link POA-3: 18" Pipe and 24" Pipe

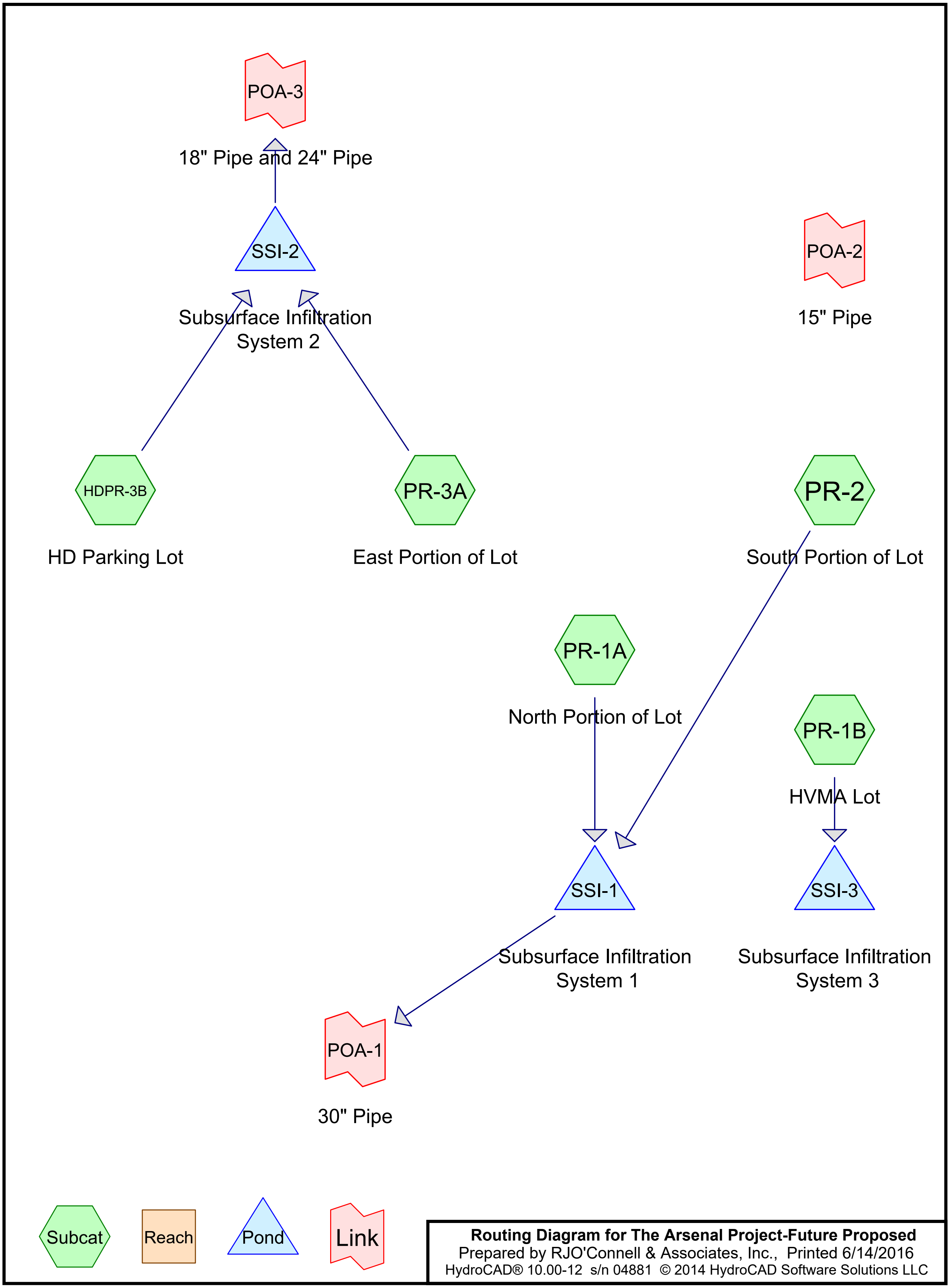
Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 5.02" for 100-Year Cornell event
Inflow = 21.26 cfs @ 12.24 hrs, Volume= 2.208 af
Primary = 21.26 cfs @ 12.24 hrs, Volume= 2.208 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Future Post-Redevelopment Hydrological Computations



Routing Diagram for The Arsenal Project-Future Proposed
Prepared by RJO'Connell & Associates, Inc., Printed 6/14/2016
HydroCAD® 10.00-12 s/n 04881 © 2014 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>2.44"
Tc=6.0 min CN=93 Runoff=4.17 cfs 0.313 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>2.75"
Tc=6.0 min CN=96 Runoff=26.48 cfs 2.069 af

Subcatchment PR-1B: HVMA Lot Runoff Area=155,841 sf 82.30% Impervious Runoff Depth>2.26"
Tc=6.0 min CN=91 Runoff=9.11 cfs 0.673 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>2.35"
Tc=6.0 min CN=92 Runoff=3.49 cfs 0.259 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>2.85"
Tc=6.0 min CN=97 Runoff=11.18 cfs 0.890 af

Pond SSI-1: Subsurface Infiltration System Peak Elev=16.17' Storage=30,244 cf Inflow=29.97 cfs 2.328 af
Discarded=5.73 cfs 2.326 af Primary=0.00 cfs 0.000 af Outflow=5.73 cfs 2.326 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=10.95' Storage=27,631 cf Inflow=15.34 cfs 1.203 af
Discarded=0.58 cfs 0.706 af Primary=0.51 cfs 0.101 af Outflow=1.08 cfs 0.807 af

Pond SSI-3: Subsurface Infiltration System 3 Peak Elev=13.79' Storage=16,289 cf Inflow=9.11 cfs 0.673 af
Outflow=0.41 cfs 0.456 af

Link POA-1: 30" Pipe Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link POA-2: 15" Pipe
Primary=0.00 cfs 0.000 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=0.51 cfs 0.101 af
Primary=0.51 cfs 0.101 af

Total Runoff Area = 19.214 ac Runoff Volume = 4.203 af Average Runoff Depth = 2.63"
7.62% Pervious = 1.464 ac 92.38% Impervious = 17.749 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

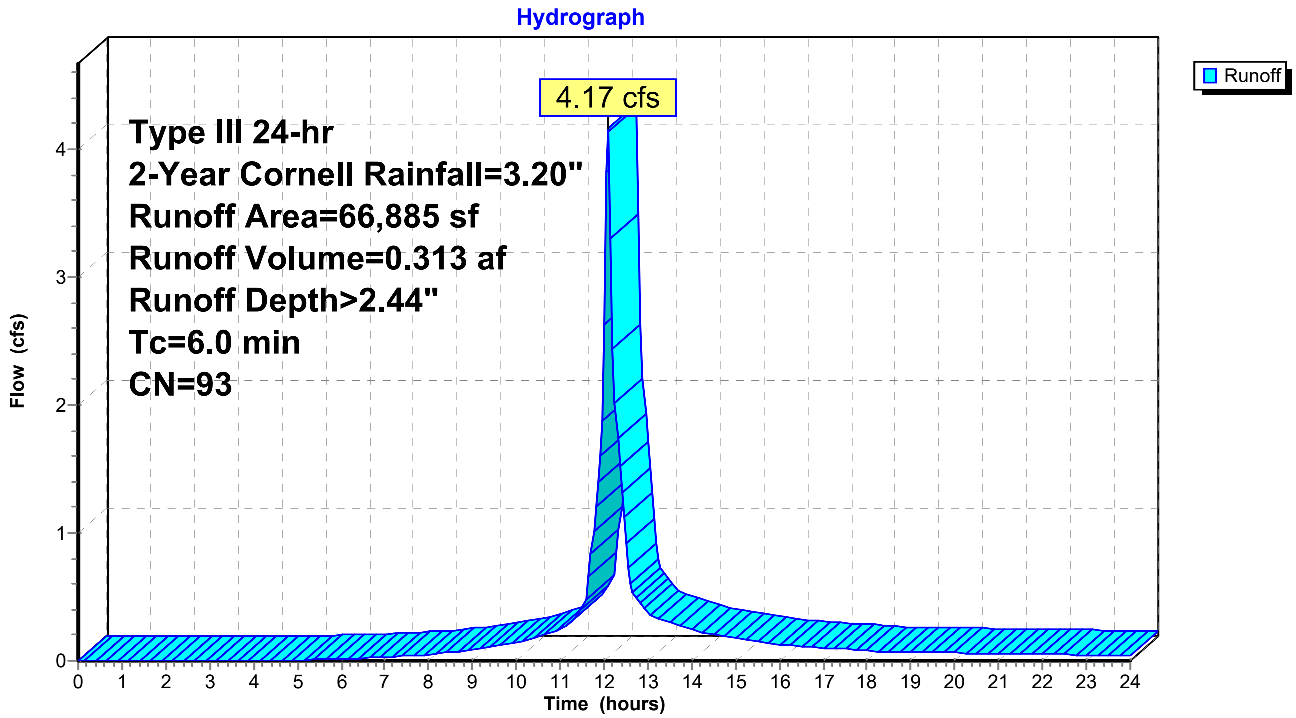
Runoff = 4.17 cfs @ 12.09 hrs, Volume= 0.313 af, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

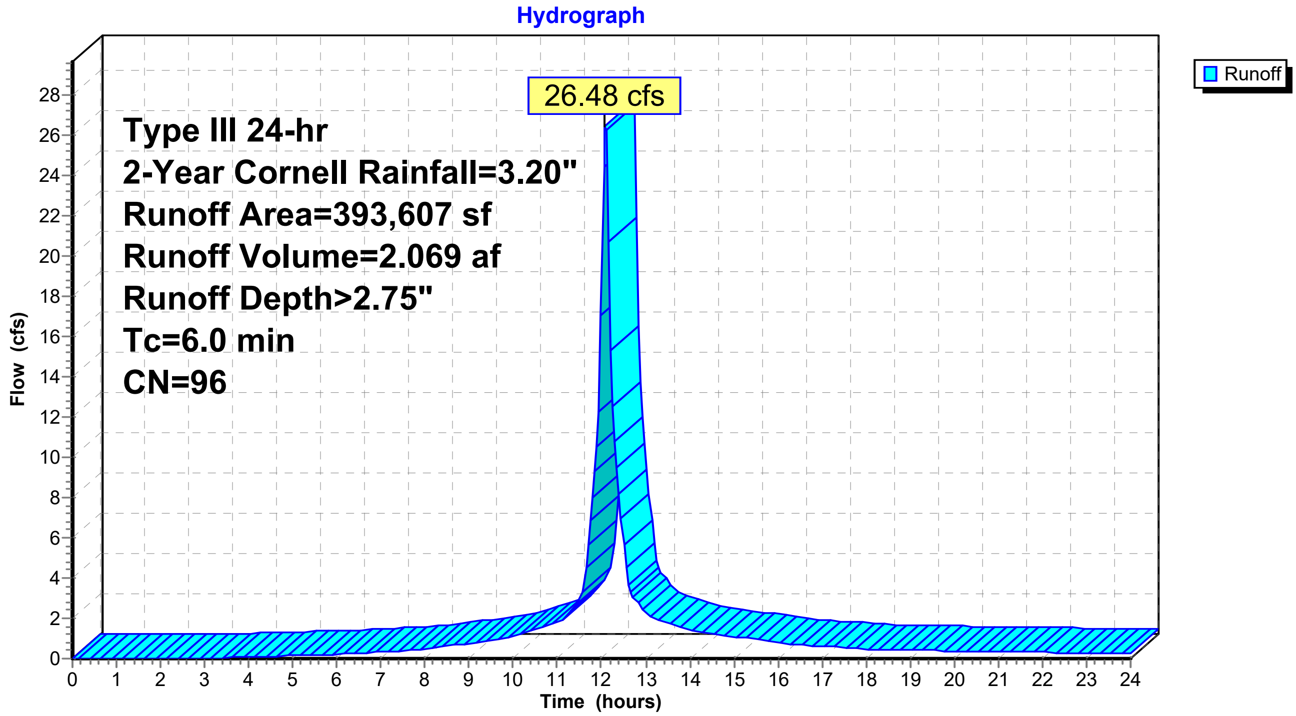
Runoff = 26.48 cfs @ 12.09 hrs, Volume= 2.069 af, Depth> 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

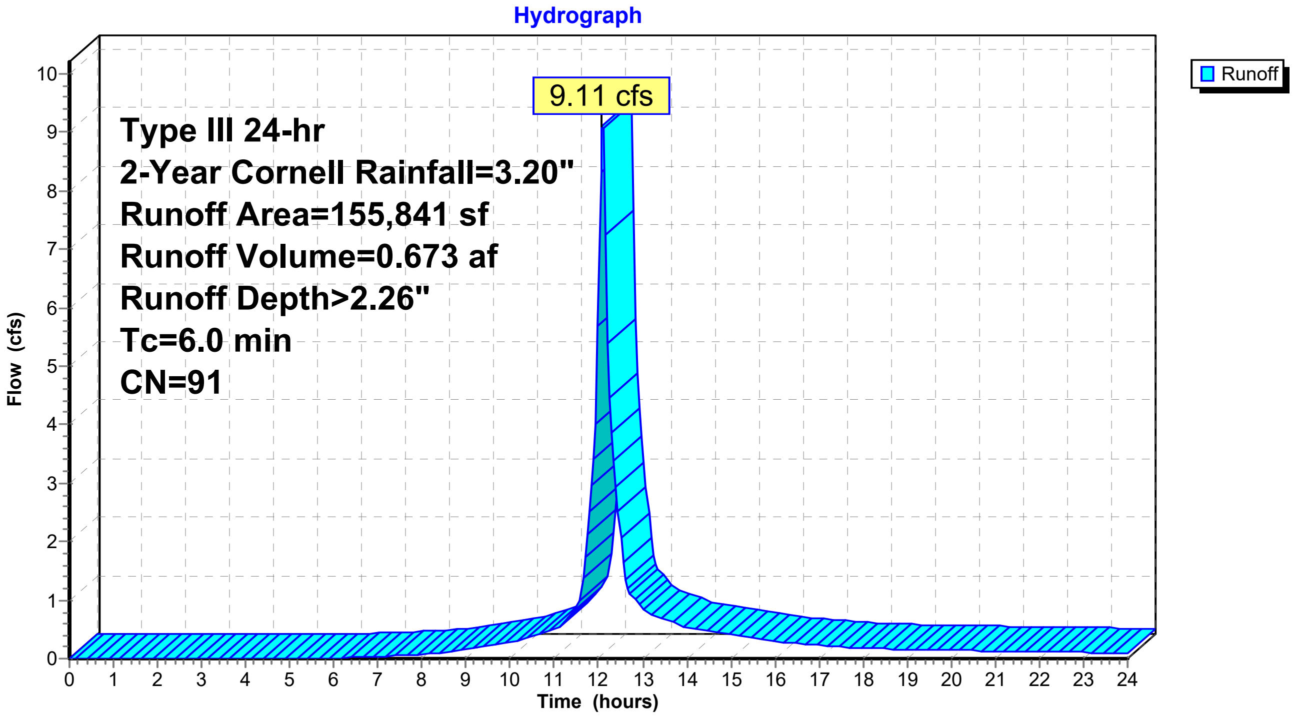
Runoff = 9.11 cfs @ 12.09 hrs, Volume= 0.673 af, Depth> 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
27,588	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
109,628	98	Paved parking, HSG B
155,841	91	Weighted Average
27,588		17.70% Pervious Area
128,253		82.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

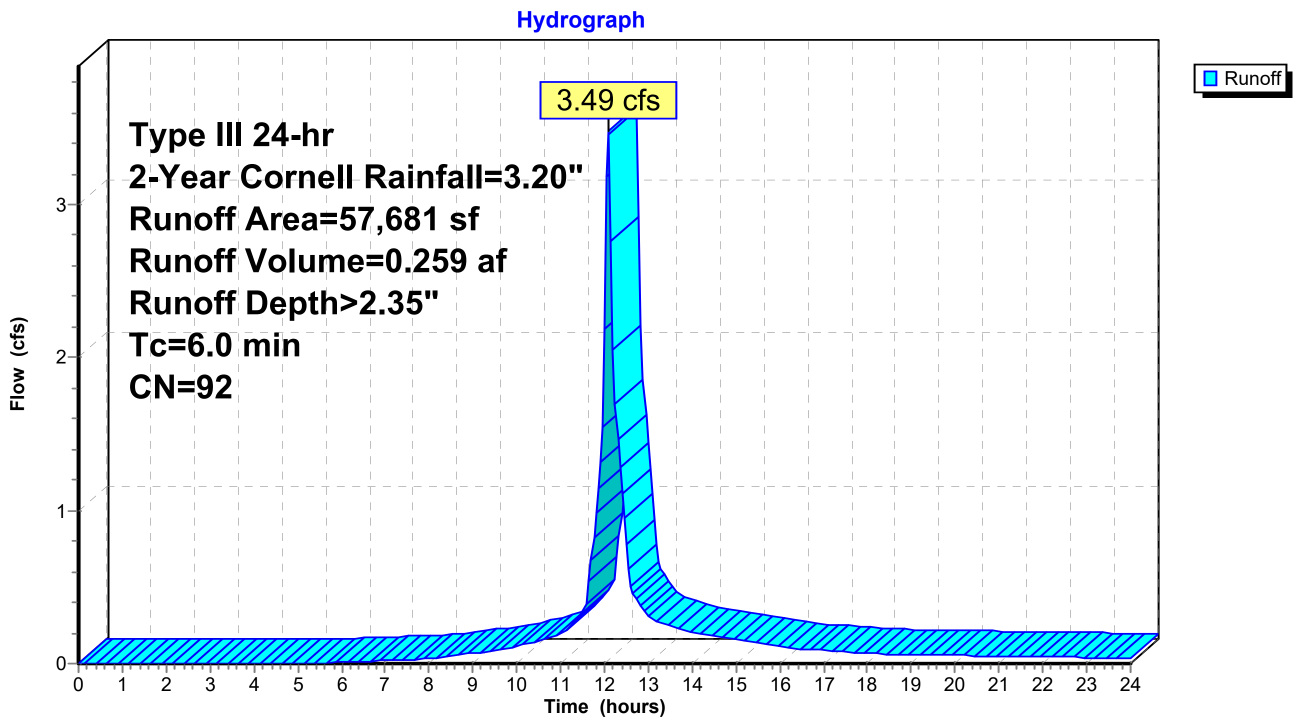
Runoff = 3.49 cfs @ 12.09 hrs, Volume= 0.259 af, Depth> 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

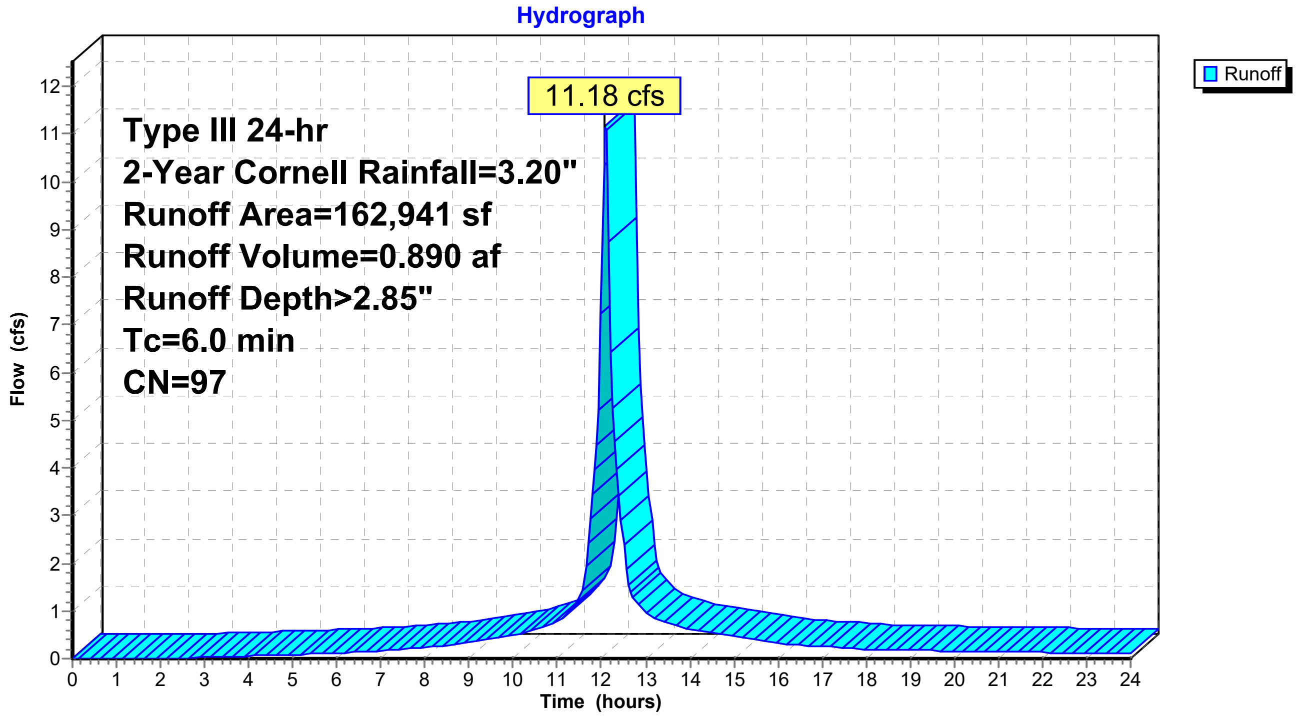
Runoff = 11.18 cfs @ 12.09 hrs, Volume= 0.890 af, Depth> 2.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Cornell Rainfall=3.20"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth > 2.70" for 2-Year Cornell event
Inflow = 29.97 cfs @ 12.09 hrs, Volume= 2.328 af
Outflow = 5.73 cfs @ 12.53 hrs, Volume= 2.326 af, Atten= 81%, Lag= 26.4 min
Discarded = 5.73 cfs @ 12.53 hrs, Volume= 2.326 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 16.17' @ 12.53 hrs Surf.Area= 14,652 sf Storage= 30,244 cf

Plug-Flow detention time= 38.6 min calculated for 2.321 af (100% of inflow)
Center-of-Mass det. time= 38.0 min (814.2 - 776.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=5.73 cfs @ 12.53 hrs HW=16.17' (Free Discharge)
└─**2=Exfiltration** (Controls 5.73 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

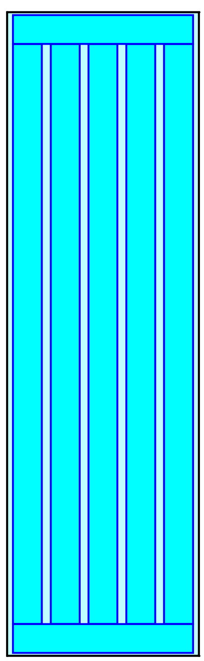
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

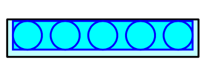
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 = 88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone Storage

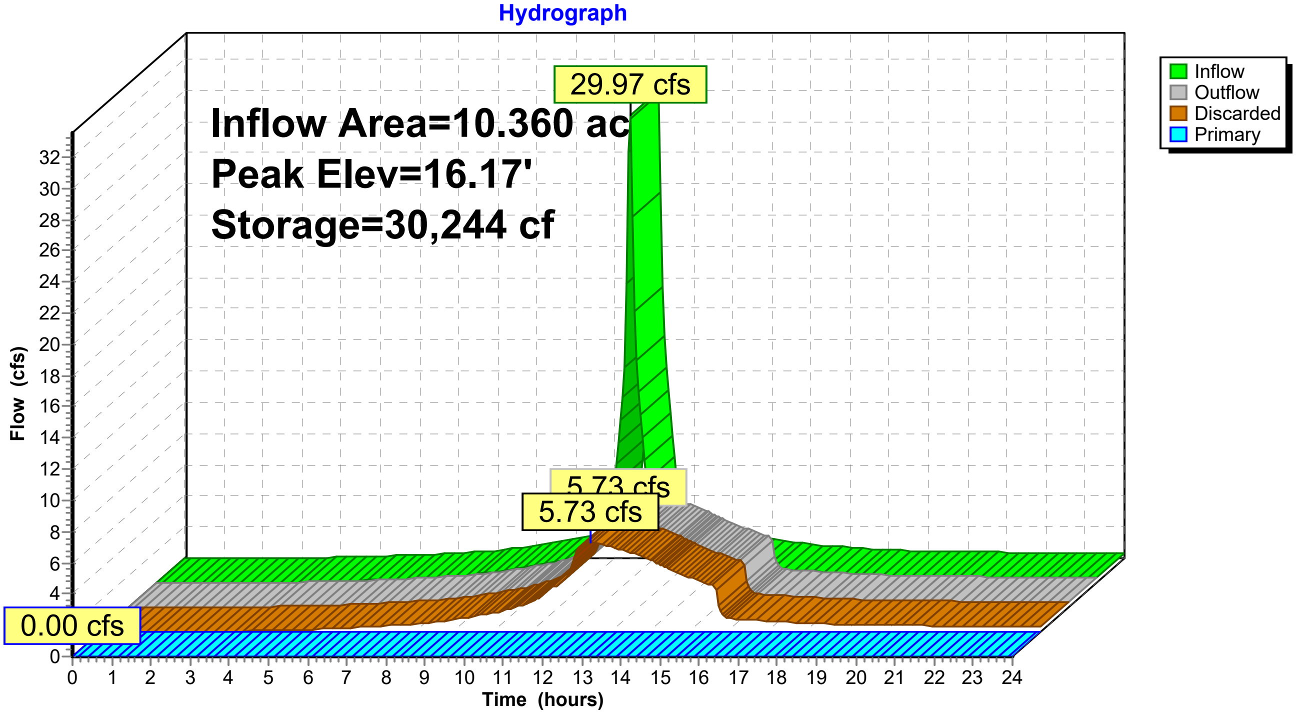
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth > 2.74" for 2-Year Cornell event
Inflow = 15.34 cfs @ 12.09 hrs, Volume= 1.203 af
Outflow = 1.08 cfs @ 13.41 hrs, Volume= 0.807 af, Atten= 93%, Lag= 79.2 min
Discarded = 0.58 cfs @ 13.41 hrs, Volume= 0.706 af
Primary = 0.51 cfs @ 13.41 hrs, Volume= 0.101 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 10.95' @ 13.41 hrs Surf.Area= 14,107 sf Storage= 27,631 cf

Plug-Flow detention time= 261.8 min calculated for 0.805 af (67% of inflow)
Center-of-Mass det. time= 166.5 min (939.0 - 772.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.58 cfs @ 13.41 hrs HW=10.95' (Free Discharge)
└─**3=Exfiltration** (Controls 0.58 cfs)

Primary OutFlow Max=0.50 cfs @ 13.41 hrs HW=10.95' (Free Discharge)
├─**1=Culvert** (Barrel Controls 0.25 cfs @ 1.95 fps)
└─**2=Culvert** (Barrel Controls 0.25 cfs @ 1.95 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

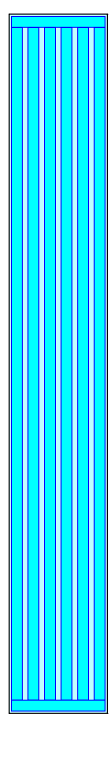
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 =
37,514.9 cf Chamber Storage

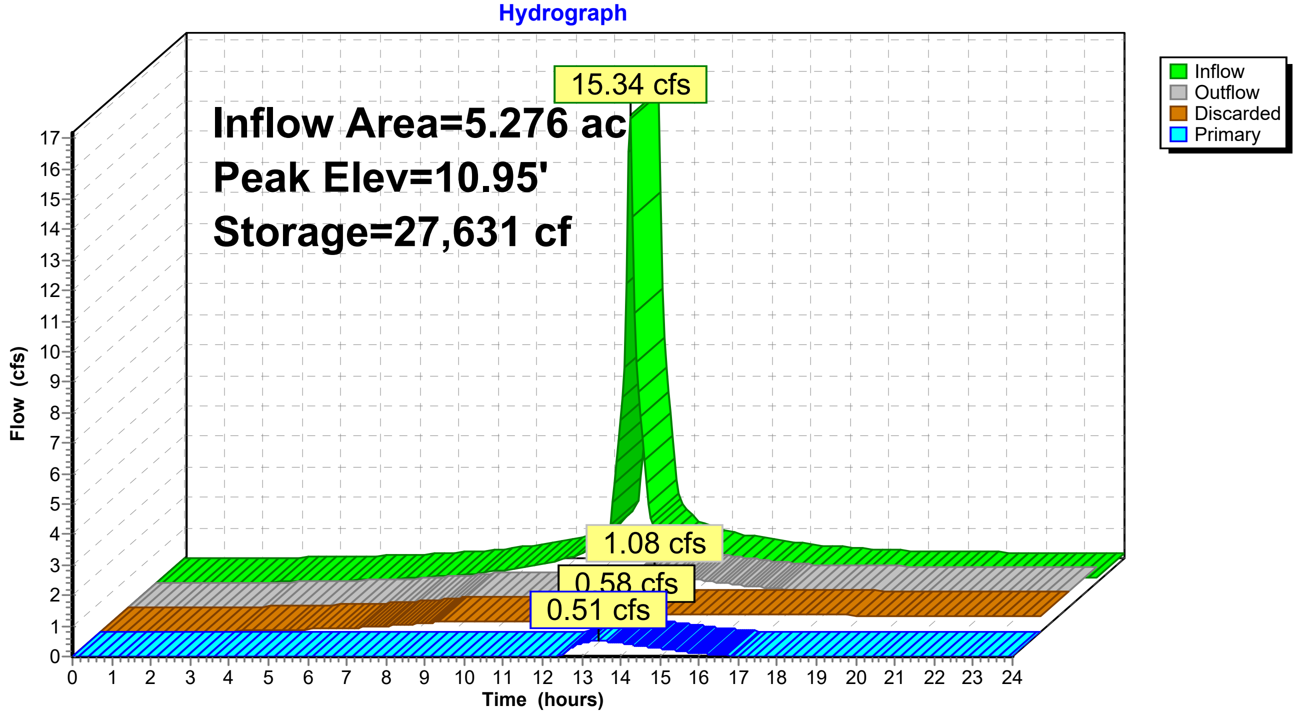
84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone



Pond SSI-2: Subsurface Infiltration System 2



Summary for Pond SSI-3: Subsurface Infiltration System 3

Inflow Area = 3.578 ac, 82.30% Impervious, Inflow Depth > 2.26" for 2-Year Cornell event
Inflow = 9.11 cfs @ 12.09 hrs, Volume= 0.673 af
Outflow = 0.41 cfs @ 14.99 hrs, Volume= 0.456 af, Atten= 95%, Lag= 174.0 min
Discarded = 0.41 cfs @ 14.99 hrs, Volume= 0.456 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 13.79' @ 14.99 hrs Surf.Area= 10,266 sf Storage= 16,289 cf

Plug-Flow detention time= 299.3 min calculated for 0.456 af (68% of inflow)
Center-of-Mass det. time= 203.9 min (1,005.9 - 802.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	11.00'	21,584 cf	**87.00'W x 118.00'L x 10.00'H Field A**
			102,660 cf Overall - 48,699 cf Embedded = 53,961 cf x 40.0% Voids
#2A	12.00'	48,699 cf	**CMP_Round 96** x 8 Inside #1
			Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf
			Overall Size= 96.0"W x 96.0"H x 20.00'L
			Row Length Adjustment= +80.00' x 50.20 sf x 8 rows
			85.00' Header x 50.20 sf x 2 = 8,534.8 cf Inside
		70,283 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	11.00'	**1.020 in/hr Exfiltration over Surface area**
			Conductivity to Groundwater Elevation = 7.00'

Discarded OutFlow Max=0.41 cfs @ 14.99 hrs HW=13.79' (Free Discharge)
└─**1=Exfiltration** (Controls 0.41 cfs)

Pond SSI-3: Subsurface Infiltration System 3 - Chamber Wizard Field A

Chamber Model = CMP_Round 96 (Round Corrugated Metal Pipe)
Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf
Overall Size= 96.0"W x 96.0"H x 20.00'L
Row Length Adjustment= +80.00' x 50.20 sf x 8 rows

96.0" Wide + 36.0" Spacing = 132.0" C-C Row Spacing

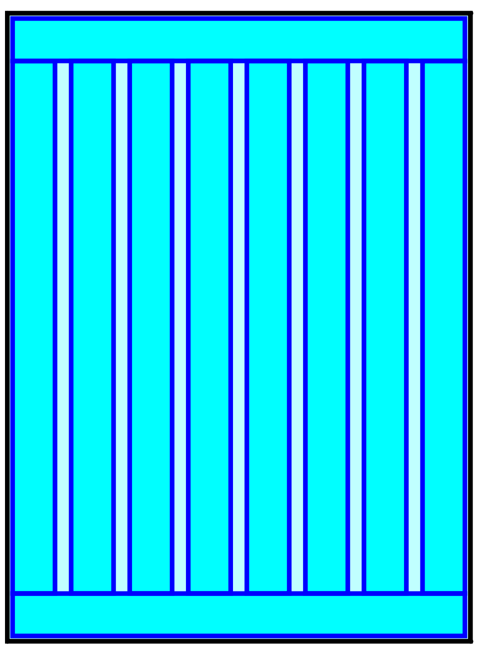
1 Chambers/Row x 20.00' Long +80.00' Row Adjustment +8.00' Header x 2 = 116.00' Row Length +12.0" End Stone x 2 = 118.00' Base Length
8 Rows x 96.0" Wide + 36.0" Spacing x 7 + 12.0" Side Stone x 2 = 87.00' Base Width
12.0" Base + 96.0" Chamber Height + 12.0" Cover = 10.00' Field Height

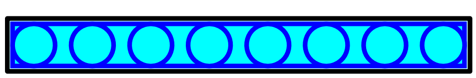
8 Chambers x 1,004.1 cf +80.00' Row Adjustment x 50.20 sf x 8 Rows + 85.00' Header x 50.20 sf x 2 = 48,698.8 cf Chamber Storage

102,660.0 cf Field - 48,698.8 cf Chambers = 53,961.1 cf Stone x 40.0% Voids = 21,584.5 cf Stone Storage

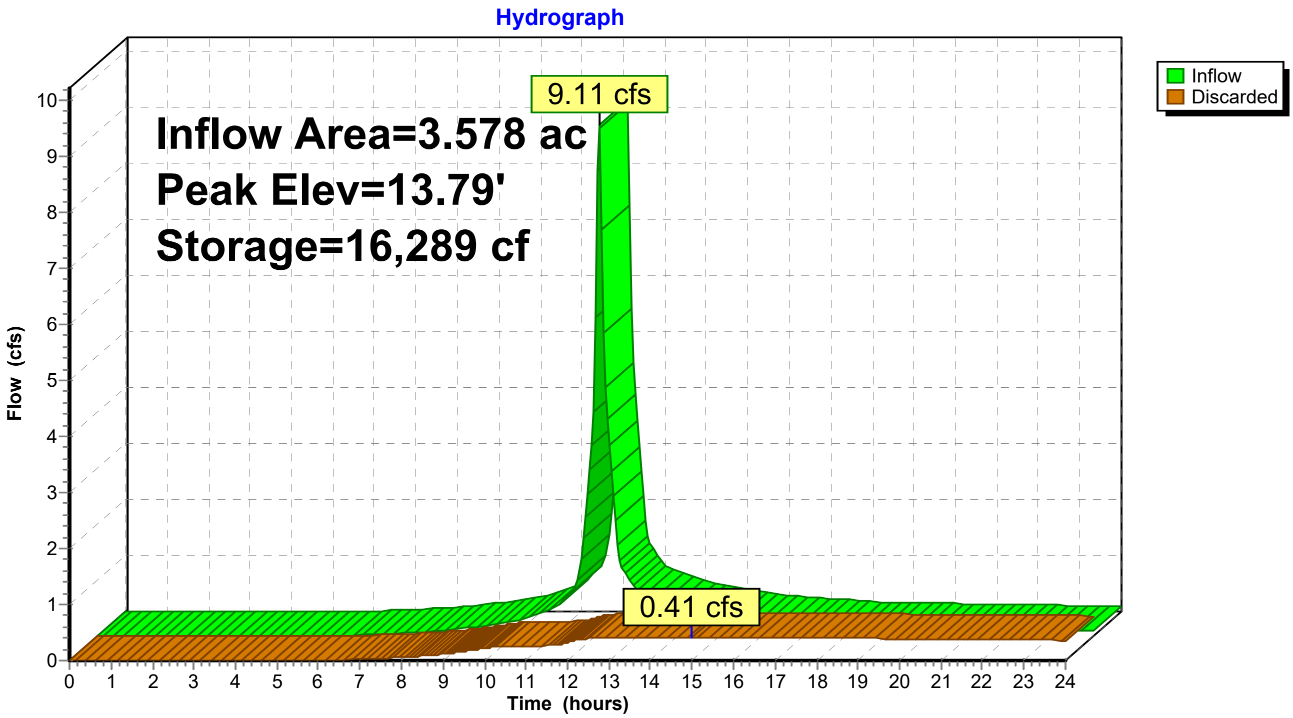
Chamber Storage + Stone Storage = 70,283.3 cf = 1.613 af
Overall Storage Efficiency = 68.5%

8 Chambers
3,802.2 cy Field
1,998.6 cy Stone





Pond SSI-3: Subsurface Infiltration System 3

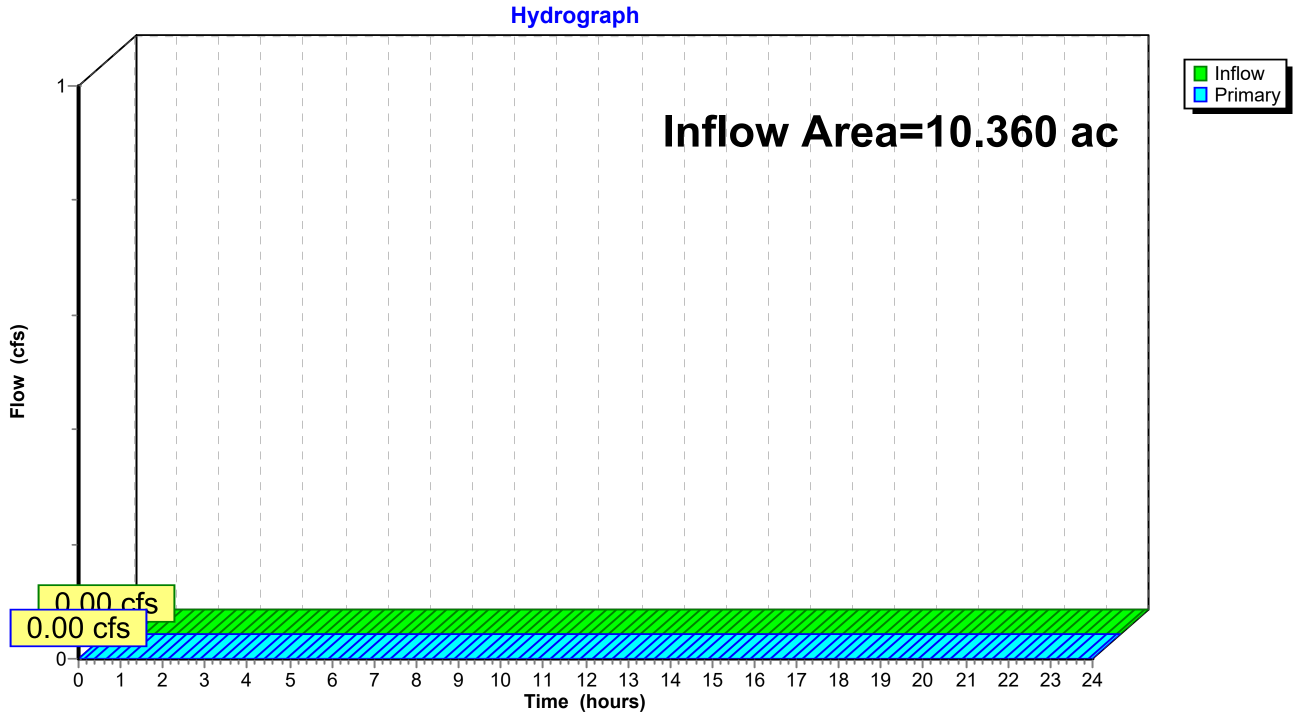


Summary for Link POA-1: 30" Pipe

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth = 0.00" for 2-Year Cornell event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

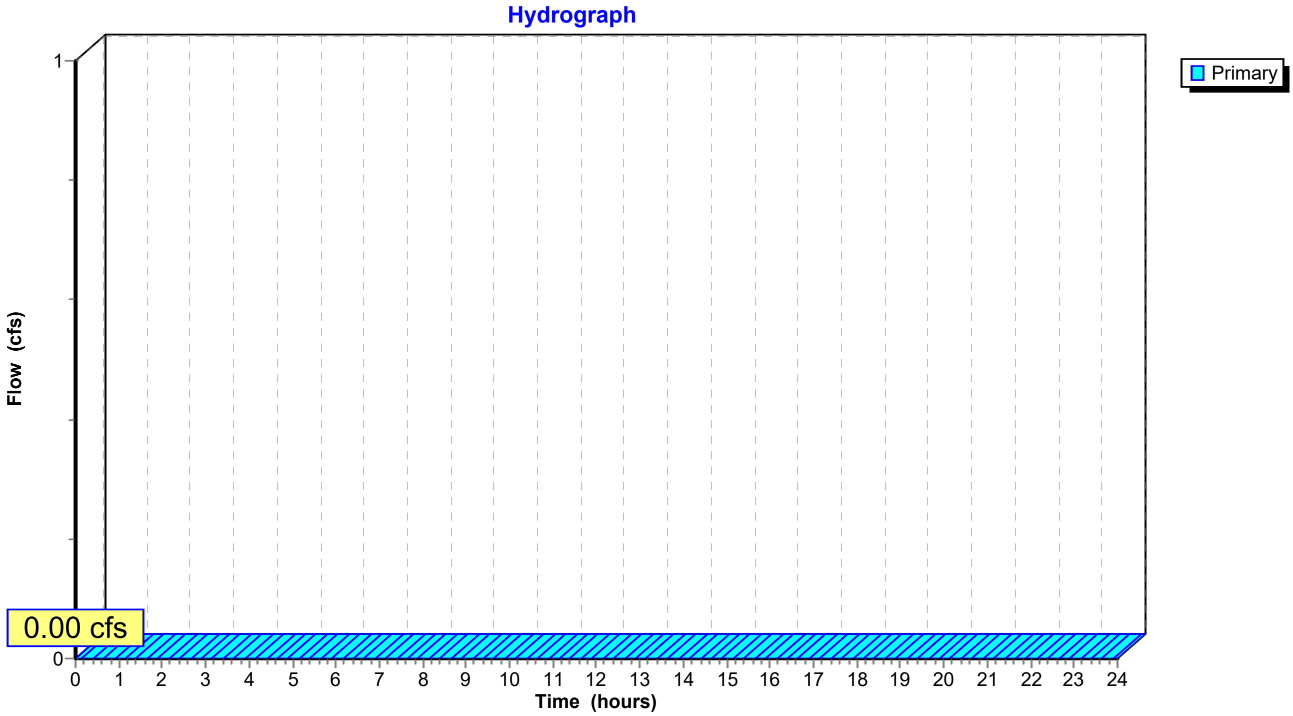


Summary for Link POA-2: 15" Pipe

Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

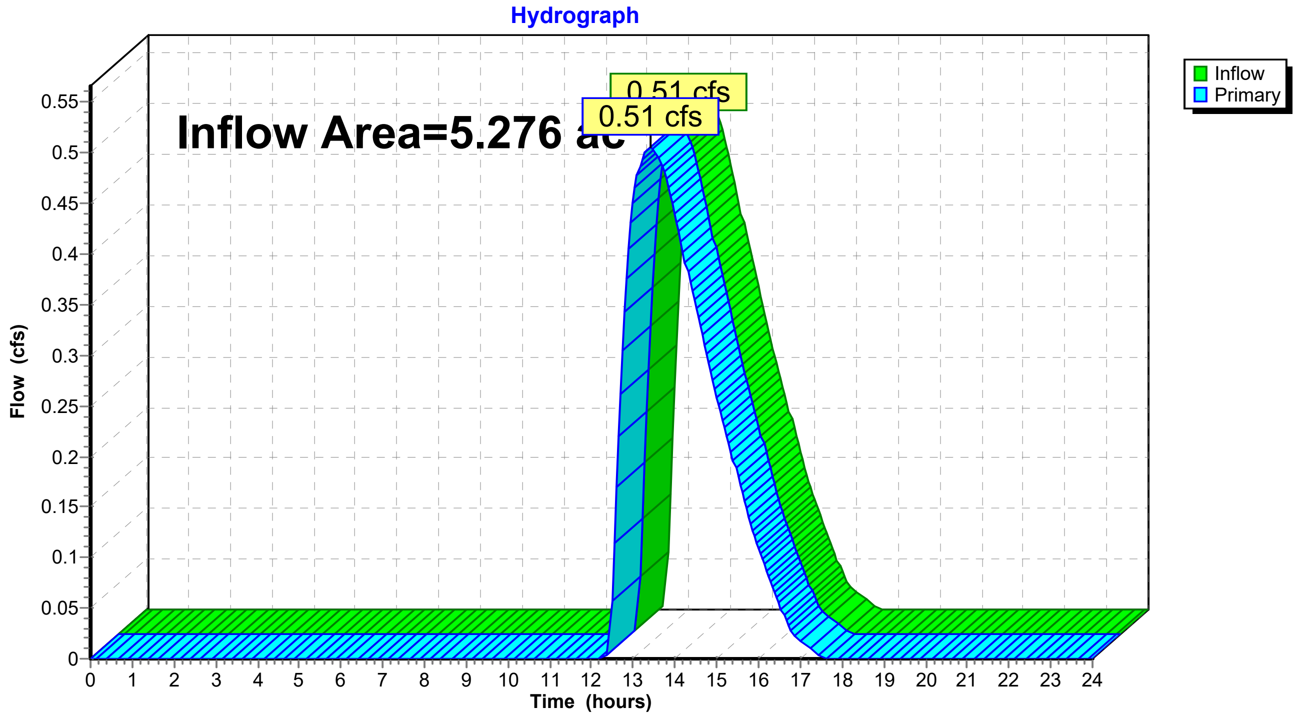


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 0.23" for 2-Year Cornell event
Inflow = 0.51 cfs @ 13.41 hrs, Volume= 0.101 af
Primary = 0.51 cfs @ 13.41 hrs, Volume= 0.101 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>4.10"
Tc=6.0 min CN=93 Runoff=6.79 cfs 0.524 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>4.43"
Tc=6.0 min CN=96 Runoff=41.59 cfs 3.336 af

Subcatchment PR-1B: HVMA Lot Runoff Area=155,841 sf 82.30% Impervious Runoff Depth>3.88"
Tc=6.0 min CN=91 Runoff=15.27 cfs 1.157 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>3.99"
Tc=6.0 min CN=92 Runoff=5.76 cfs 0.440 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>4.54"
Tc=6.0 min CN=97 Runoff=17.38 cfs 1.417 af

Pond SSI-1: Subsurface Infiltration System Peak Elev=18.32' Storage=55,609 cf Inflow=47.34 cfs 3.776 af
Discarded=7.24 cfs 3.774 af Primary=0.00 cfs 0.000 af Outflow=7.24 cfs 3.774 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=11.79' Storage=37,088 cf Inflow=24.17 cfs 1.941 af
Discarded=0.65 cfs 0.789 af Primary=6.69 cfs 0.681 af Outflow=7.34 cfs 1.470 af

Pond SSI-3: Subsurface Infiltration System Peak Elev=15.57' Storage=31,392 cf Inflow=15.27 cfs 1.157 af
Outflow=0.52 cfs 0.604 af

Link POA-1: 30" Pipe Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link POA-2: 15" Pipe
Primary=0.00 cfs 0.000 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=6.69 cfs 0.681 af
Primary=6.69 cfs 0.681 af

Total Runoff Area = 19.214 ac Runoff Volume = 6.875 af Average Runoff Depth = 4.29"
7.62% Pervious = 1.464 ac 92.38% Impervious = 17.749 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

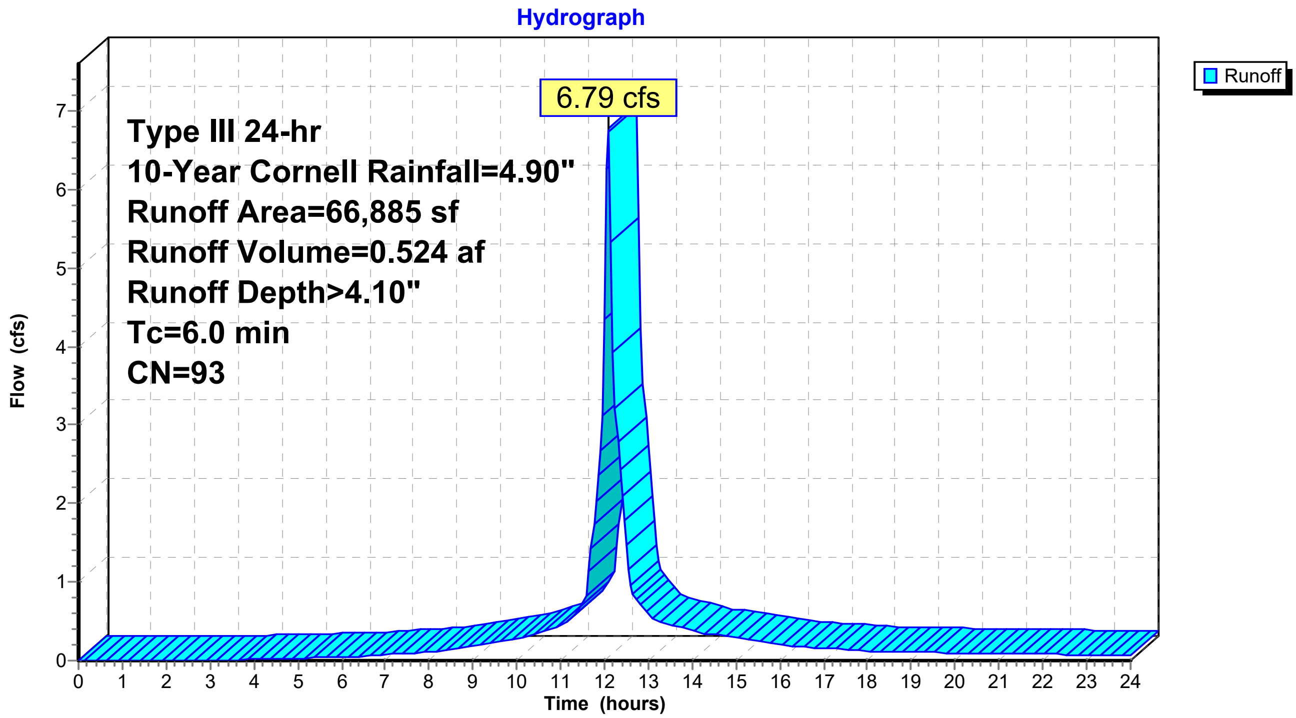
Runoff = 6.79 cfs @ 12.09 hrs, Volume= 0.524 af, Depth> 4.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

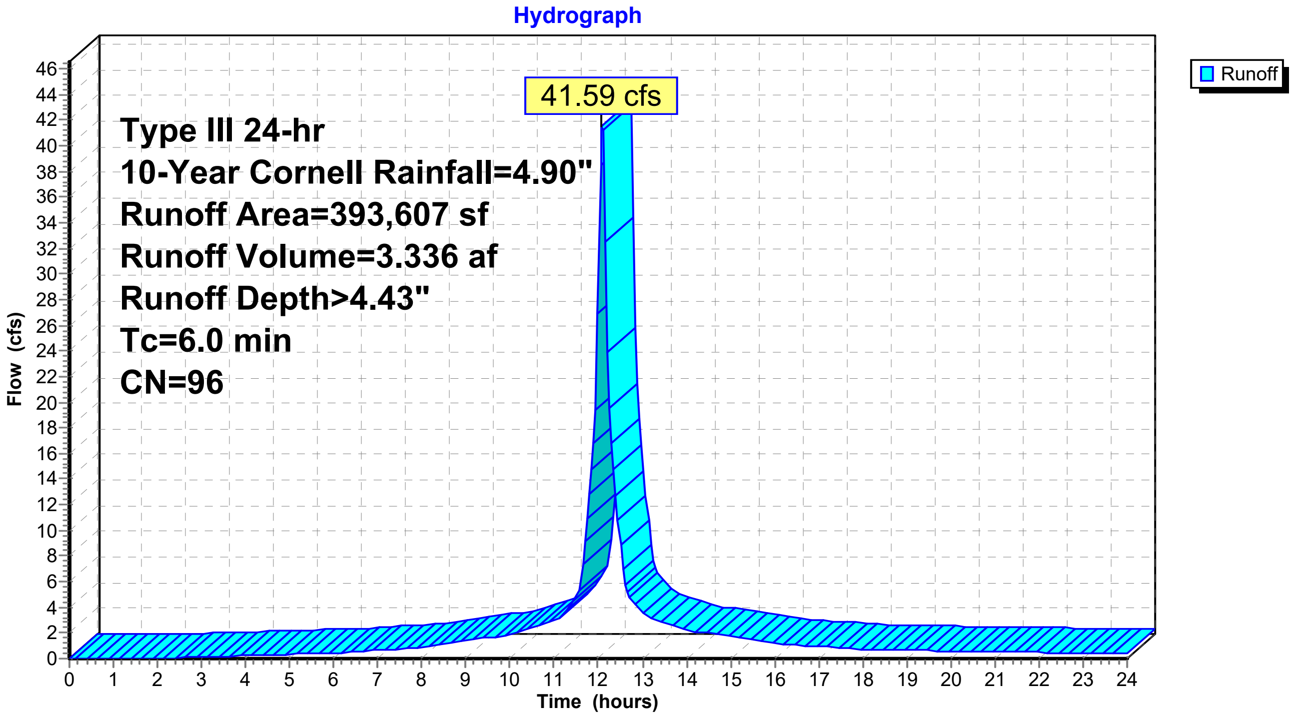
Runoff = 41.59 cfs @ 12.09 hrs, Volume= 3.336 af, Depth> 4.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

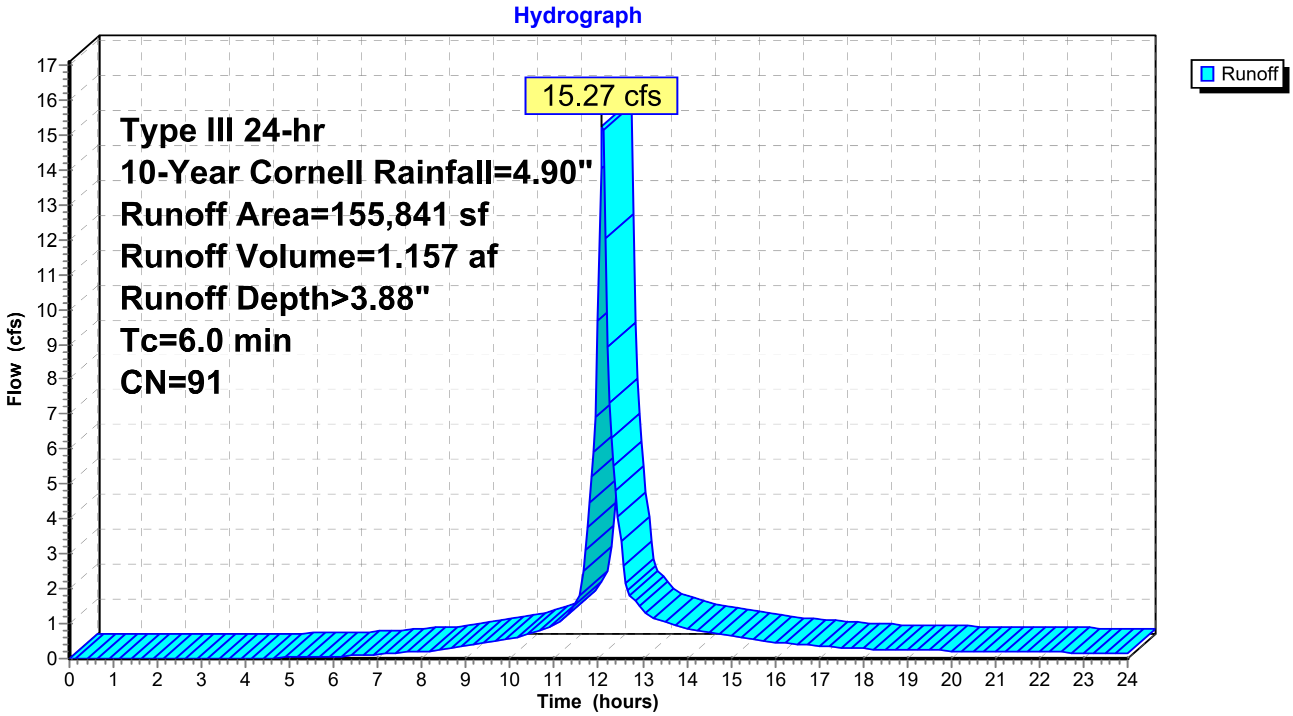
Runoff = 15.27 cfs @ 12.09 hrs, Volume= 1.157 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
27,588	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
109,628	98	Paved parking, HSG B
155,841	91	Weighted Average
27,588		17.70% Pervious Area
128,253		82.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

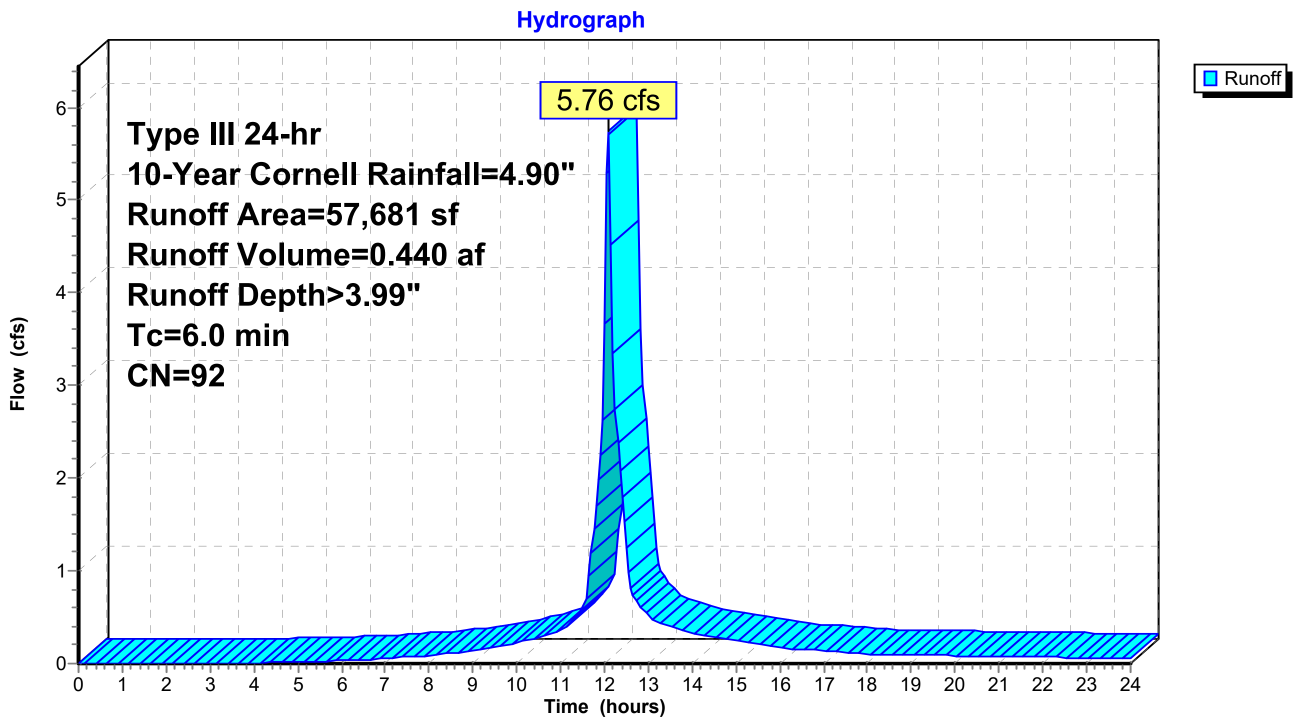
Runoff = 5.76 cfs @ 12.09 hrs, Volume= 0.440 af, Depth> 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

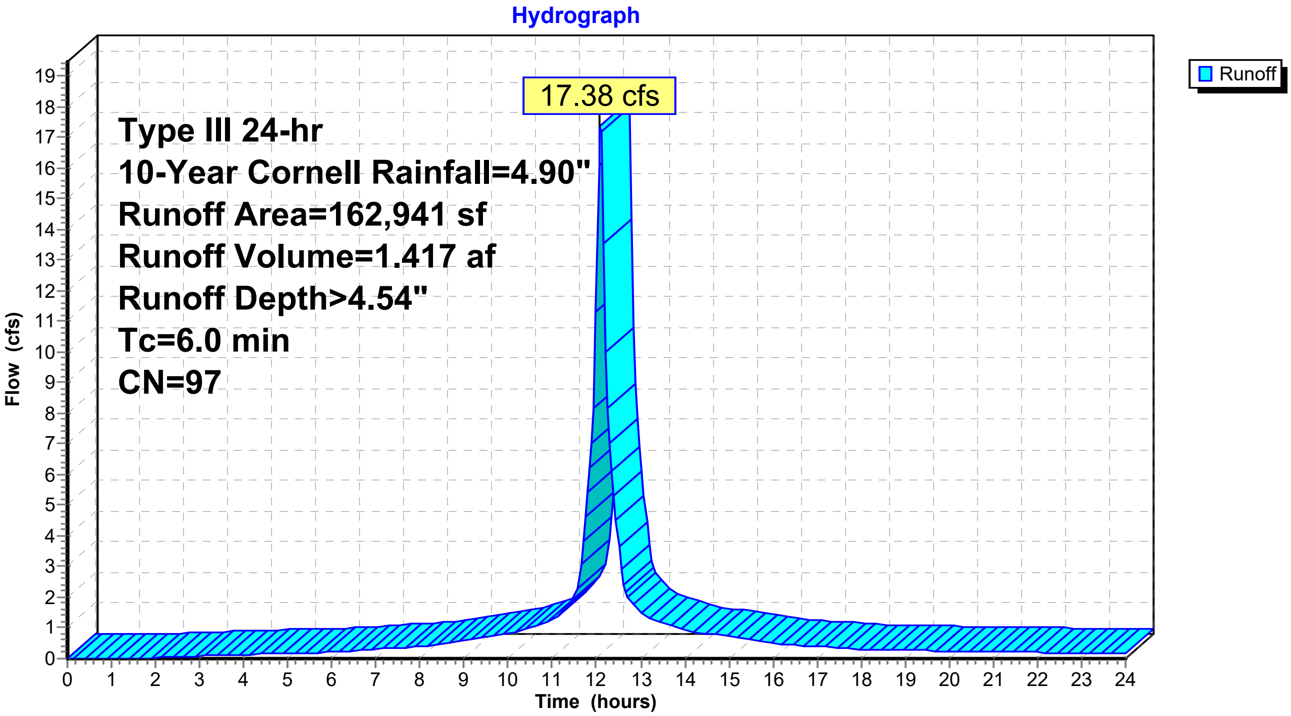
Runoff = 17.38 cfs @ 12.09 hrs, Volume= 1.417 af, Depth> 4.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Cornell Rainfall=4.90"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth > 4.37" for 10-Year Cornell event
Inflow = 47.34 cfs @ 12.09 hrs, Volume= 3.776 af
Outflow = 7.24 cfs @ 12.58 hrs, Volume= 3.774 af, Atten= 85%, Lag= 29.4 min
Discarded = 7.24 cfs @ 12.58 hrs, Volume= 3.774 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 18.32' @ 12.58 hrs Surf.Area= 14,652 sf Storage= 55,609 cf

Plug-Flow detention time= 61.7 min calculated for 3.766 af (100% of inflow)
Center-of-Mass det. time= 61.1 min (825.9 - 764.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=7.24 cfs @ 12.58 hrs HW=18.32' (Free Discharge)
└─**2=Exfiltration** (Controls 7.24 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

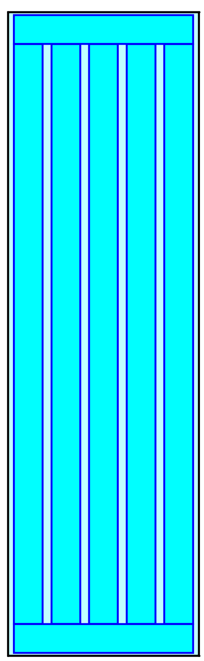
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

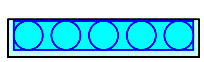
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 = 88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone Storage

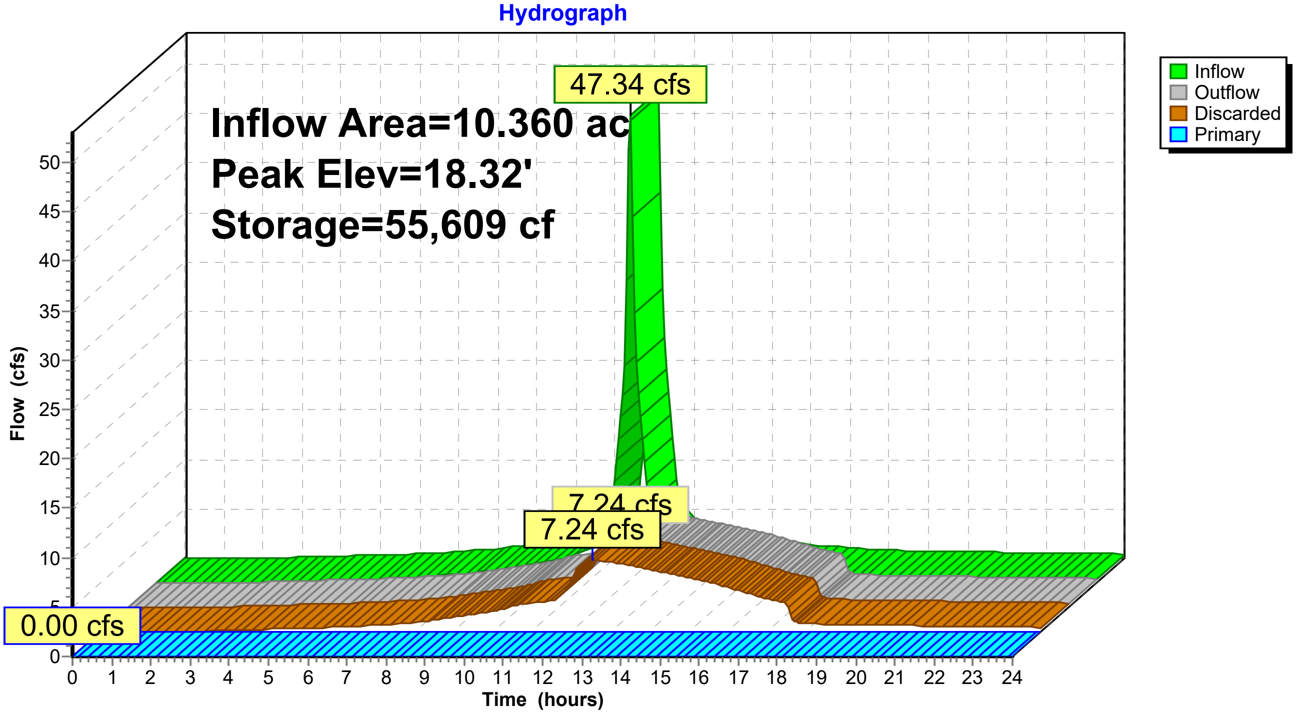
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth > 4.41" for 10-Year Cornell event
Inflow = 24.17 cfs @ 12.09 hrs, Volume= 1.941 af
Outflow = 7.34 cfs @ 12.40 hrs, Volume= 1.470 af, Atten= 70%, Lag= 19.1 min
Discarded = 0.65 cfs @ 12.41 hrs, Volume= 0.789 af
Primary = 6.69 cfs @ 12.40 hrs, Volume= 0.681 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 11.79' @ 12.41 hrs Surf.Area= 14,107 sf Storage= 37,088 cf

Plug-Flow detention time= 180.8 min calculated for 1.467 af (76% of inflow)
Center-of-Mass det. time= 97.7 min (859.6 - 761.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.65 cfs @ 12.41 hrs HW=11.79' (Free Discharge)
└**3=Exfiltration** (Controls 0.65 cfs)

Primary OutFlow Max=6.68 cfs @ 12.40 hrs HW=11.79' (Free Discharge)
├**1=Culvert** (Barrel Controls 3.34 cfs @ 3.40 fps)
└**2=Culvert** (Barrel Controls 3.34 cfs @ 3.40 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

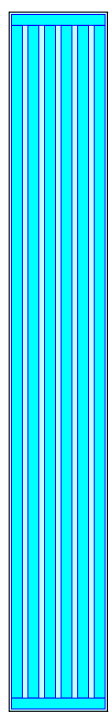
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

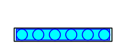
6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 =
37,514.9 cf Chamber Storage

84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

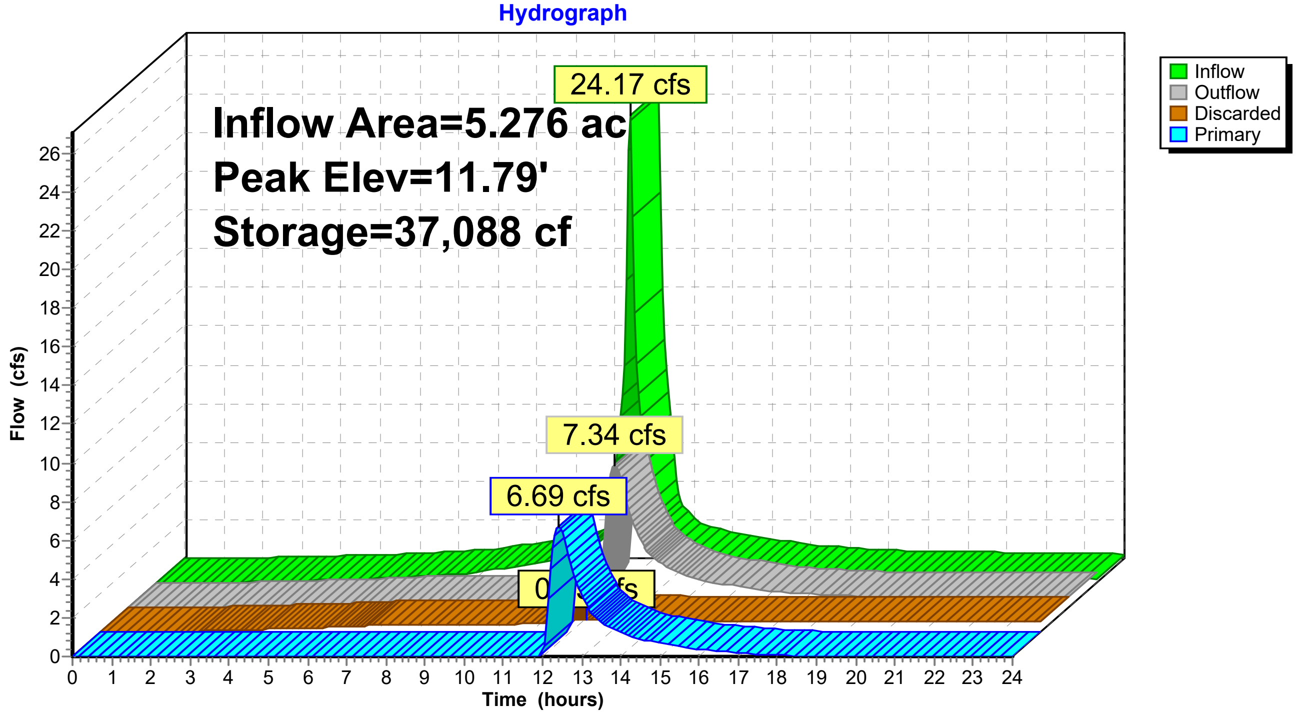
Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone





Pond SSI-2: Subsurface Infiltration System 2



Summary for Pond SSI-3: Subsurface Infiltration System 3

Inflow Area = 3.578 ac, 82.30% Impervious, Inflow Depth > 3.88" for 10-Year Cornell event
Inflow = 15.27 cfs @ 12.09 hrs, Volume= 1.157 af
Outflow = 0.52 cfs @ 15.70 hrs, Volume= 0.604 af, Atten= 97%, Lag= 216.6 min
Discarded = 0.52 cfs @ 15.70 hrs, Volume= 0.604 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 15.57' @ 15.70 hrs Surf.Area= 10,266 sf Storage= 31,392 cf

Plug-Flow detention time= 310.7 min calculated for 0.603 af (52% of inflow)
Center-of-Mass det. time= 200.5 min (987.6 - 787.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	11.00'	21,584 cf	**87.00'W x 118.00'L x 10.00'H Field A**
			102,660 cf Overall - 48,699 cf Embedded = 53,961 cf x 40.0% Voids
#2A	12.00'	48,699 cf	**CMP_Round 96** x 8 Inside #1
			Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf
			Overall Size= 96.0"W x 96.0"H x 20.00'L
			Row Length Adjustment= +80.00' x 50.20 sf x 8 rows
			85.00' Header x 50.20 sf x 2 = 8,534.8 cf Inside
		70,283 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	11.00'	**1.020 in/hr Exfiltration over Surface area**
			Conductivity to Groundwater Elevation = 7.00'

Discarded OutFlow Max=0.52 cfs @ 15.70 hrs HW=15.57' (Free Discharge)
└─**1=Exfiltration** (Controls 0.52 cfs)

Pond SSI-3: Subsurface Infiltration System 3 - Chamber Wizard Field A

Chamber Model = CMP_Round 96 (Round Corrugated Metal Pipe)
Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf
Overall Size= 96.0"W x 96.0"H x 20.00'L
Row Length Adjustment= +80.00' x 50.20 sf x 8 rows

96.0" Wide + 36.0" Spacing = 132.0" C-C Row Spacing

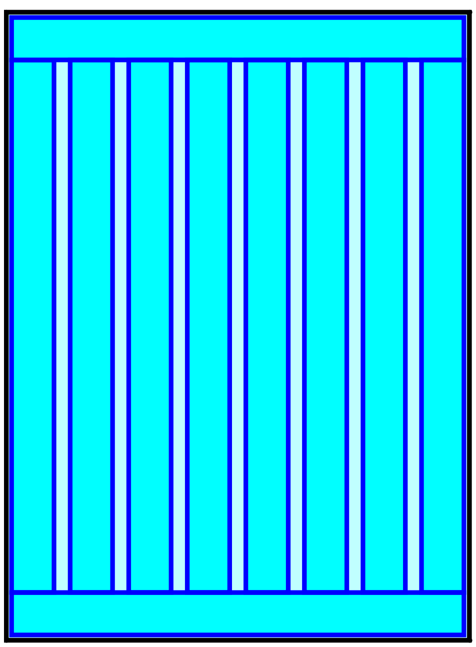
1 Chambers/Row x 20.00' Long +80.00' Row Adjustment +8.00' Header x 2 = 116.00' Row Length +12.0" End Stone x 2 = 118.00' Base Length
8 Rows x 96.0" Wide + 36.0" Spacing x 7 + 12.0" Side Stone x 2 = 87.00' Base Width
12.0" Base + 96.0" Chamber Height + 12.0" Cover = 10.00' Field Height

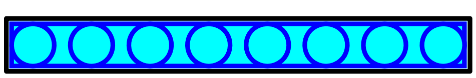
8 Chambers x 1,004.1 cf +80.00' Row Adjustment x 50.20 sf x 8 Rows + 85.00' Header x 50.20 sf x 2 = 48,698.8 cf Chamber Storage

102,660.0 cf Field - 48,698.8 cf Chambers = 53,961.1 cf Stone x 40.0% Voids = 21,584.5 cf Stone Storage

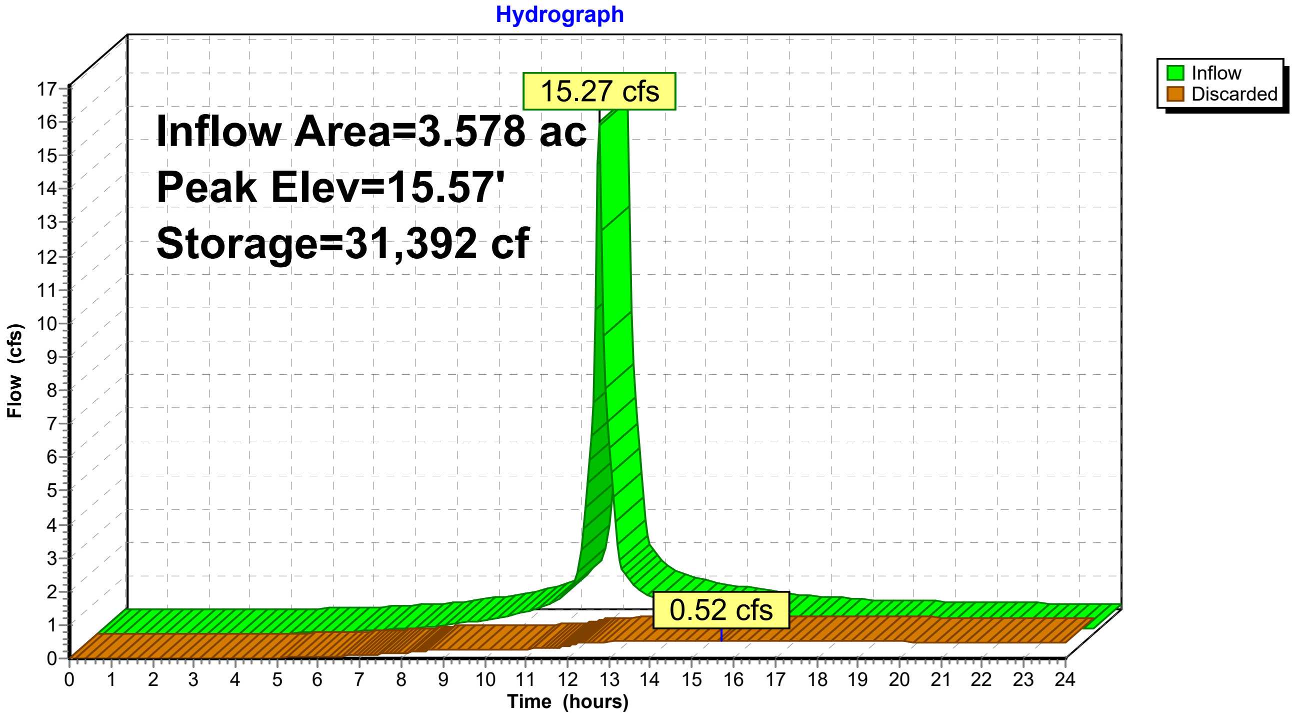
Chamber Storage + Stone Storage = 70,283.3 cf = 1.613 af
Overall Storage Efficiency = 68.5%

8 Chambers
3,802.2 cy Field
1,998.6 cy Stone





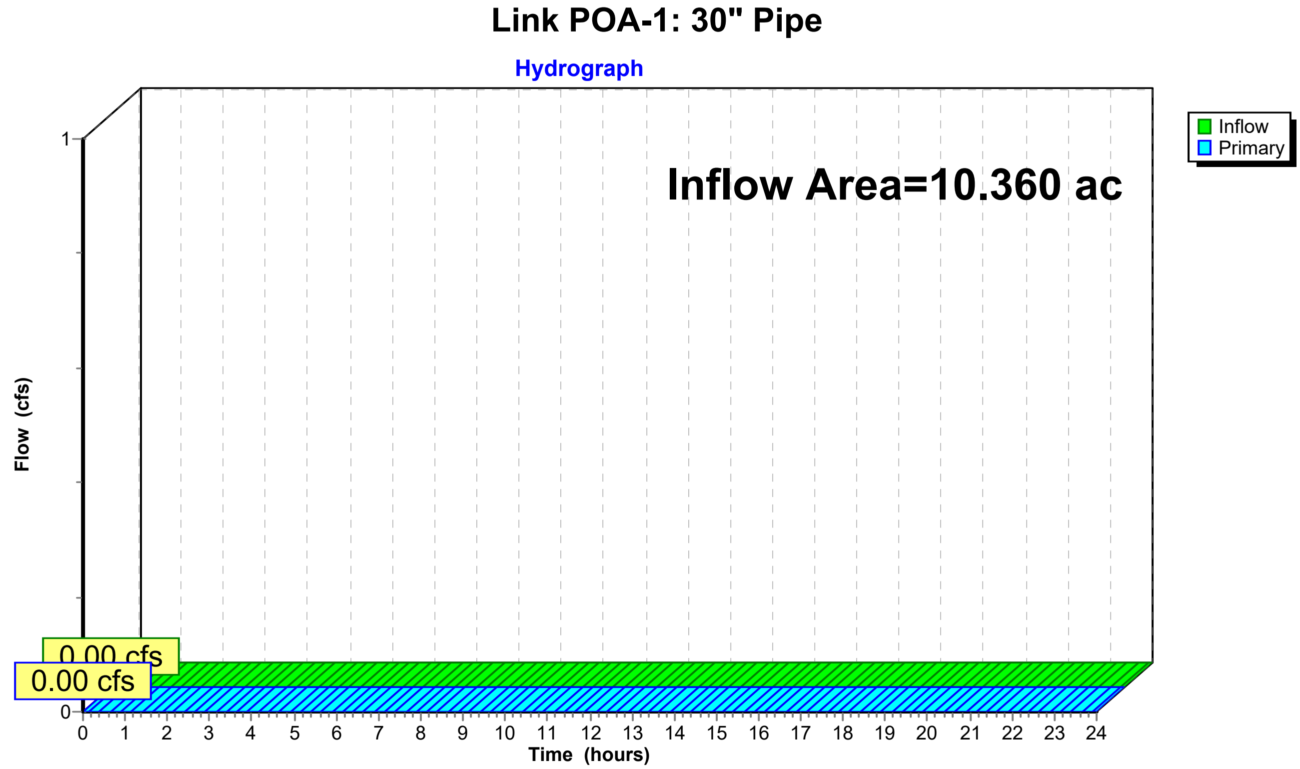
Pond SSI-3: Subsurface Infiltration System 3



Summary for Link POA-1: 30" Pipe

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth = 0.00" for 10-Year Cornell event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

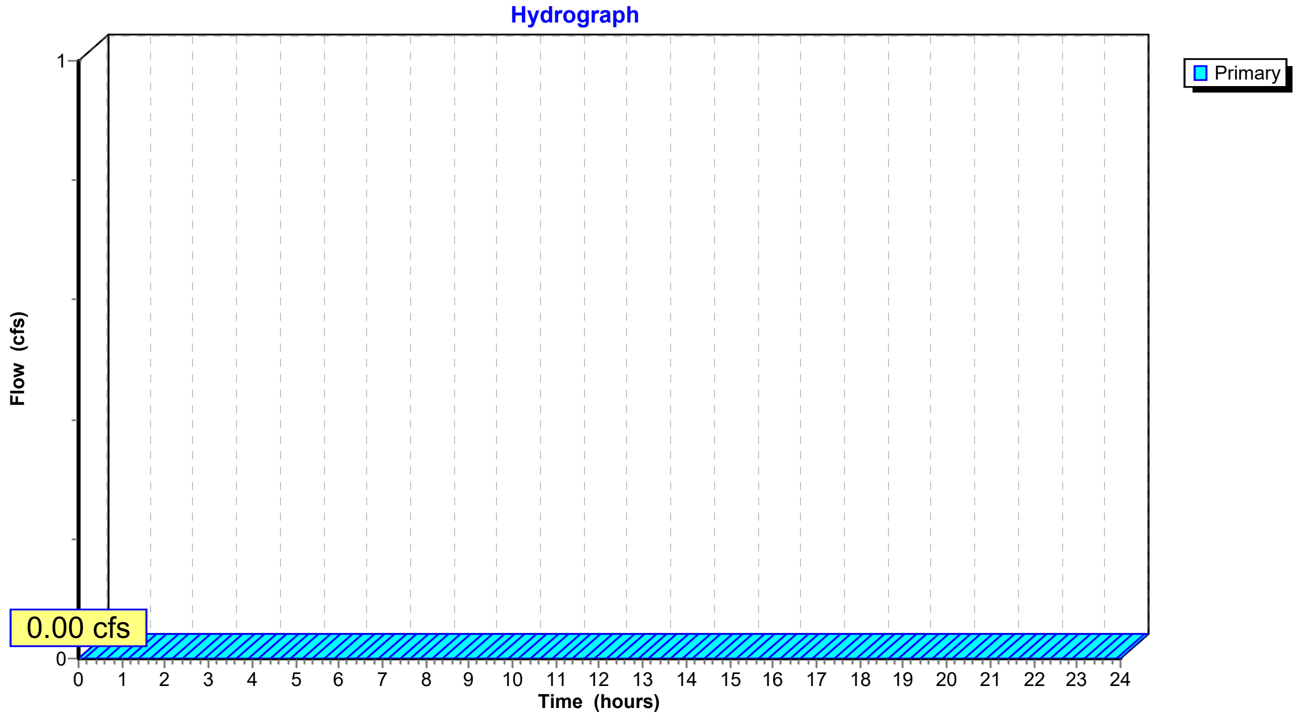


Summary for Link POA-2: 15" Pipe

Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

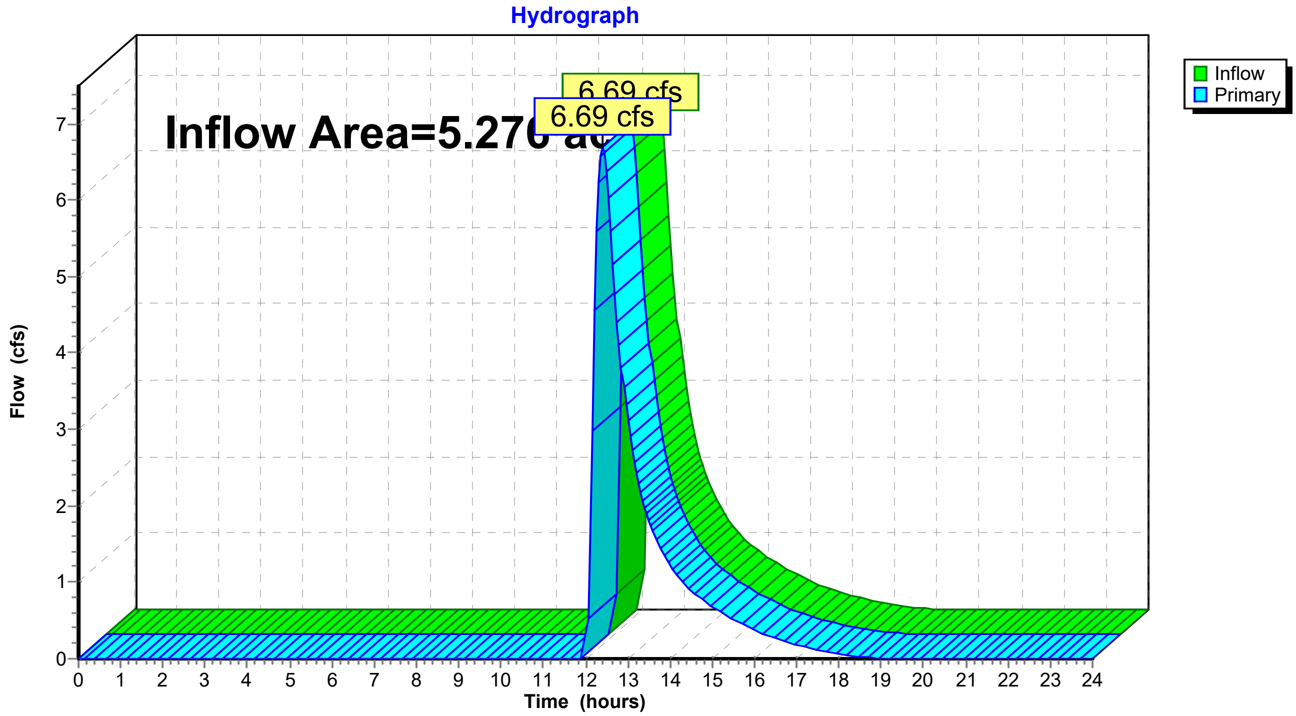


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 1.55" for 10-Year Cornell event
Inflow = 6.69 cfs @ 12.40 hrs, Volume= 0.681 af
Primary = 6.69 cfs @ 12.40 hrs, Volume= 0.681 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>5.38"
Tc=6.0 min CN=93 Runoff=8.77 cfs 0.688 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>5.72"
Tc=6.0 min CN=96 Runoff=53.04 cfs 4.309 af

Subcatchment PR-1B: HVMA Lot Runoff Area=155,841 sf 82.30% Impervious Runoff Depth>5.15"
Tc=6.0 min CN=91 Runoff=19.93 cfs 1.535 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>5.26"
Tc=6.0 min CN=92 Runoff=7.47 cfs 0.581 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>5.84"
Tc=6.0 min CN=97 Runoff=22.09 cfs 1.820 af

Pond SSI-1: Subsurface Infiltration System Peak Elev=19.99' Storage=76,525 cf Inflow=60.51 cfs 4.890 af
Discarded=8.41 cfs 4.887 af Primary=0.00 cfs 0.000 af Outflow=8.41 cfs 4.887 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=12.37' Storage=43,368 cf Inflow=30.86 cfs 2.508 af
Discarded=0.70 cfs 0.838 af Primary=12.74 cfs 1.158 af Outflow=13.44 cfs 1.996 af

Pond SSI-3: Subsurface Infiltration System Peak Elev=16.97' Storage=43,556 cf Inflow=19.93 cfs 1.535 af
Outflow=0.60 cfs 0.712 af

Link POA-1: 30" Pipe Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link POA-2: 15" Pipe
Primary=0.00 cfs 0.000 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=12.74 cfs 1.158 af
Primary=12.74 cfs 1.158 af

Total Runoff Area = 19.214 ac Runoff Volume = 8.934 af Average Runoff Depth = 5.58"
7.62% Pervious = 1.464 ac 92.38% Impervious = 17.749 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

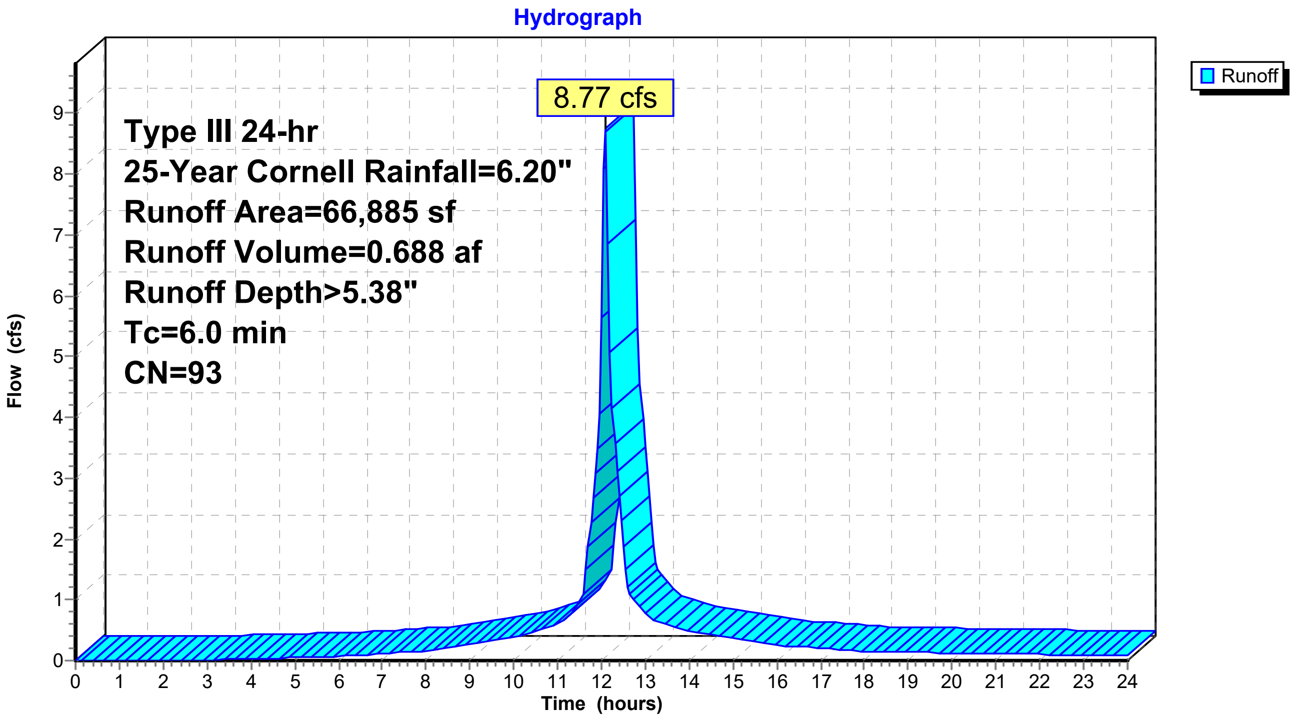
Runoff = 8.77 cfs @ 12.09 hrs, Volume= 0.688 af, Depth> 5.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

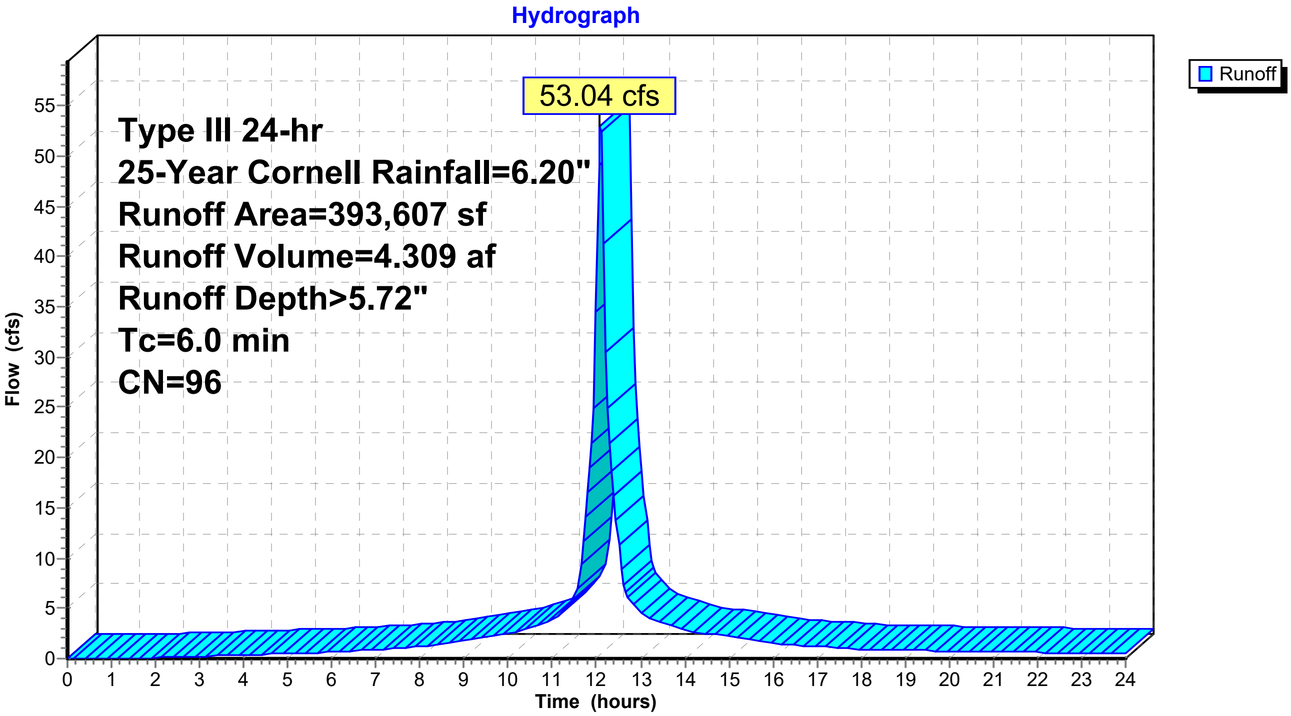
Runoff = 53.04 cfs @ 12.09 hrs, Volume= 4.309 af, Depth> 5.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

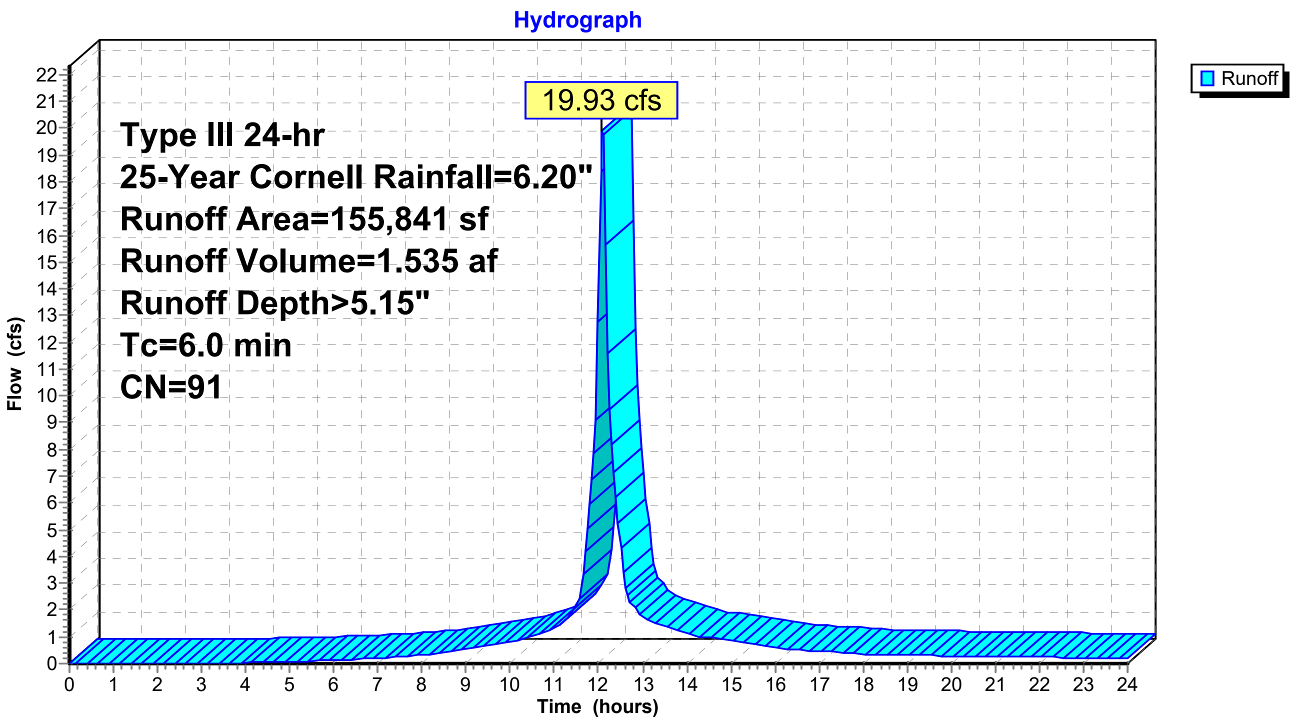
Runoff = 19.93 cfs @ 12.09 hrs, Volume= 1.535 af, Depth> 5.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
27,588	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
109,628	98	Paved parking, HSG B
155,841	91	Weighted Average
27,588		17.70% Pervious Area
128,253		82.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

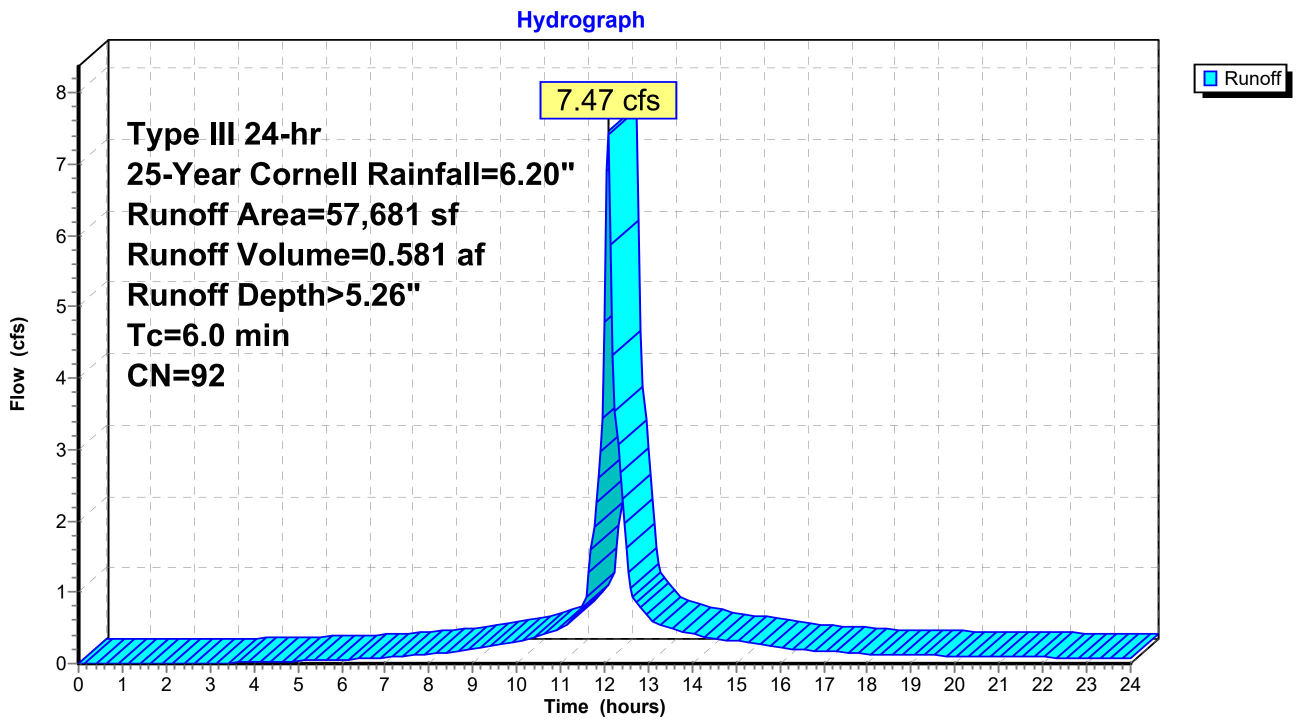
Runoff = 7.47 cfs @ 12.09 hrs, Volume= 0.581 af, Depth> 5.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

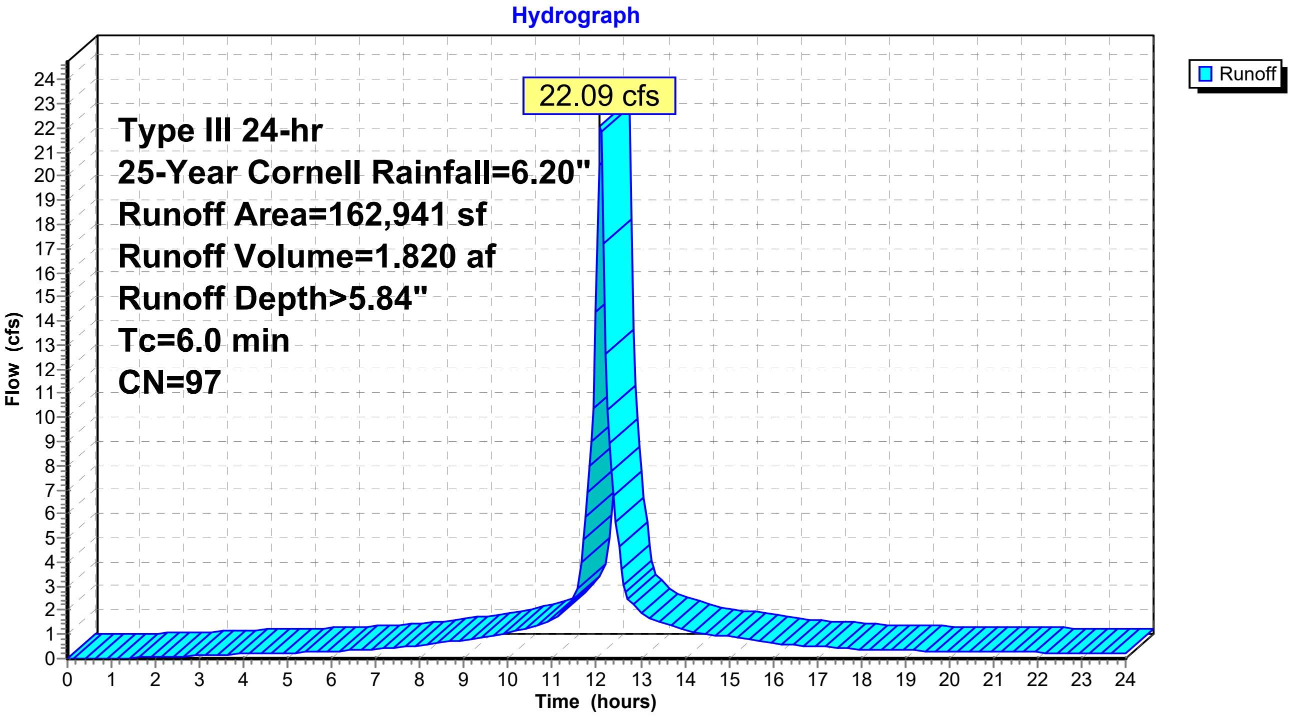
Runoff = 22.09 cfs @ 12.09 hrs, Volume= 1.820 af, Depth> 5.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Cornell Rainfall=6.20"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth > 5.66" for 25-Year Cornell event
Inflow = 60.51 cfs @ 12.09 hrs, Volume= 4.890 af
Outflow = 8.41 cfs @ 12.61 hrs, Volume= 4.887 af, Atten= 86%, Lag= 31.2 min
Discarded = 8.41 cfs @ 12.61 hrs, Volume= 4.887 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 19.99' @ 12.61 hrs Surf.Area= 14,652 sf Storage= 76,525 cf

Plug-Flow detention time= 78.0 min calculated for 4.877 af (100% of inflow)
Center-of-Mass det. time= 77.4 min (836.7 - 759.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A** 190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1 Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf Overall Size= 120.0"W x 120.0"H x 20.00'L Row Length Adjustment= +180.00' x 78.43 sf x 5 rows 62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=8.40 cfs @ 12.61 hrs HW=19.99' (Free Discharge)
└─**2=Exfiltration** (Controls 8.40 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

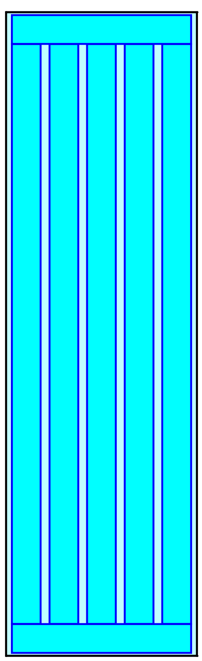
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

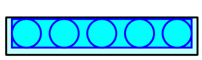
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 =
88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone
Storage

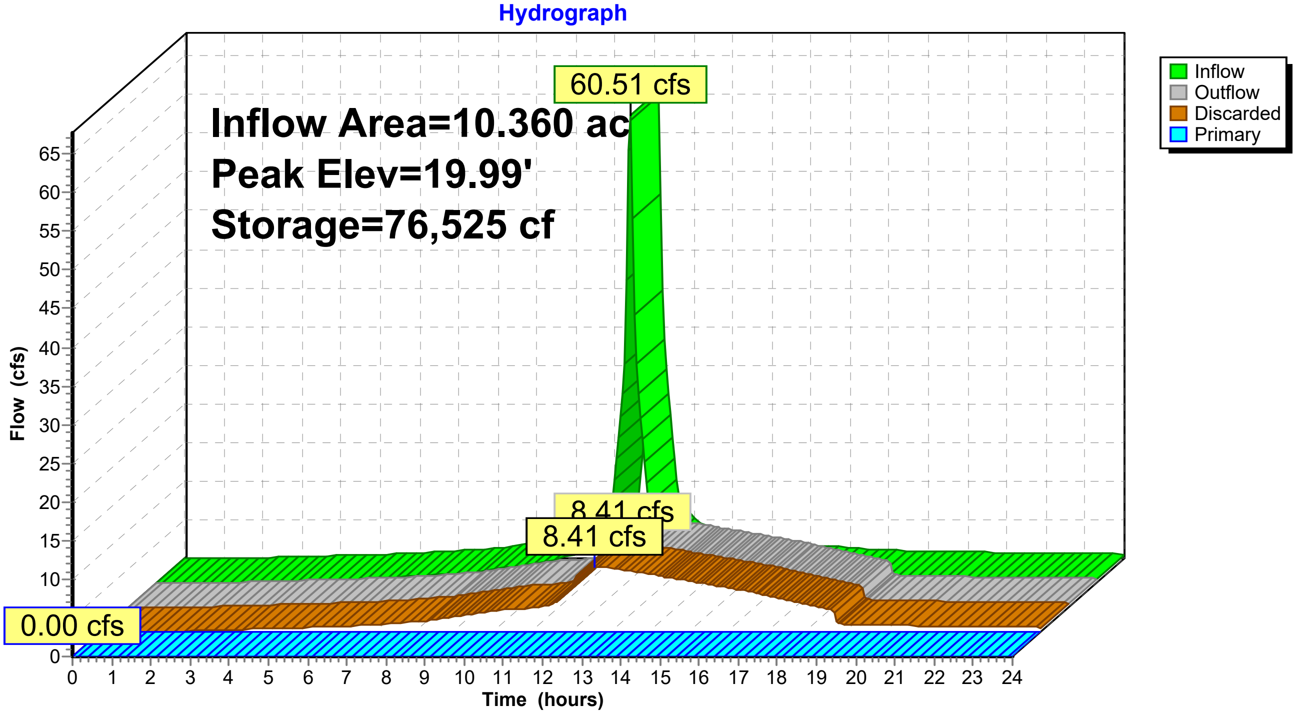
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth > 5.71" for 25-Year Cornell event
Inflow = 30.86 cfs @ 12.09 hrs, Volume= 2.508 af
Outflow = 13.44 cfs @ 12.28 hrs, Volume= 1.996 af, Atten= 56%, Lag= 11.4 min
Discarded = 0.70 cfs @ 12.28 hrs, Volume= 0.838 af
Primary = 12.74 cfs @ 12.28 hrs, Volume= 1.158 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 12.37' @ 12.28 hrs Surf.Area= 14,107 sf Storage= 43,368 cf

Plug-Flow detention time= 152.6 min calculated for 1.991 af (79% of inflow)
Center-of-Mass det. time= 76.5 min (833.2 - 756.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.70 cfs @ 12.28 hrs HW=12.37' (Free Discharge)
└─**3=Exfiltration** (Controls 0.70 cfs)

Primary OutFlow Max=12.71 cfs @ 12.28 hrs HW=12.37' (Free Discharge)
├─**1=Culvert** (Barrel Controls 6.35 cfs @ 4.04 fps)
└─**2=Culvert** (Barrel Controls 6.35 cfs @ 4.04 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

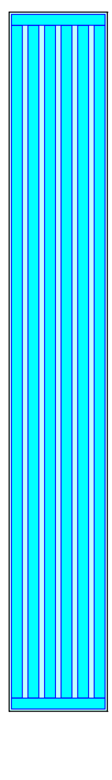
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 = 37,514.9 cf Chamber Storage

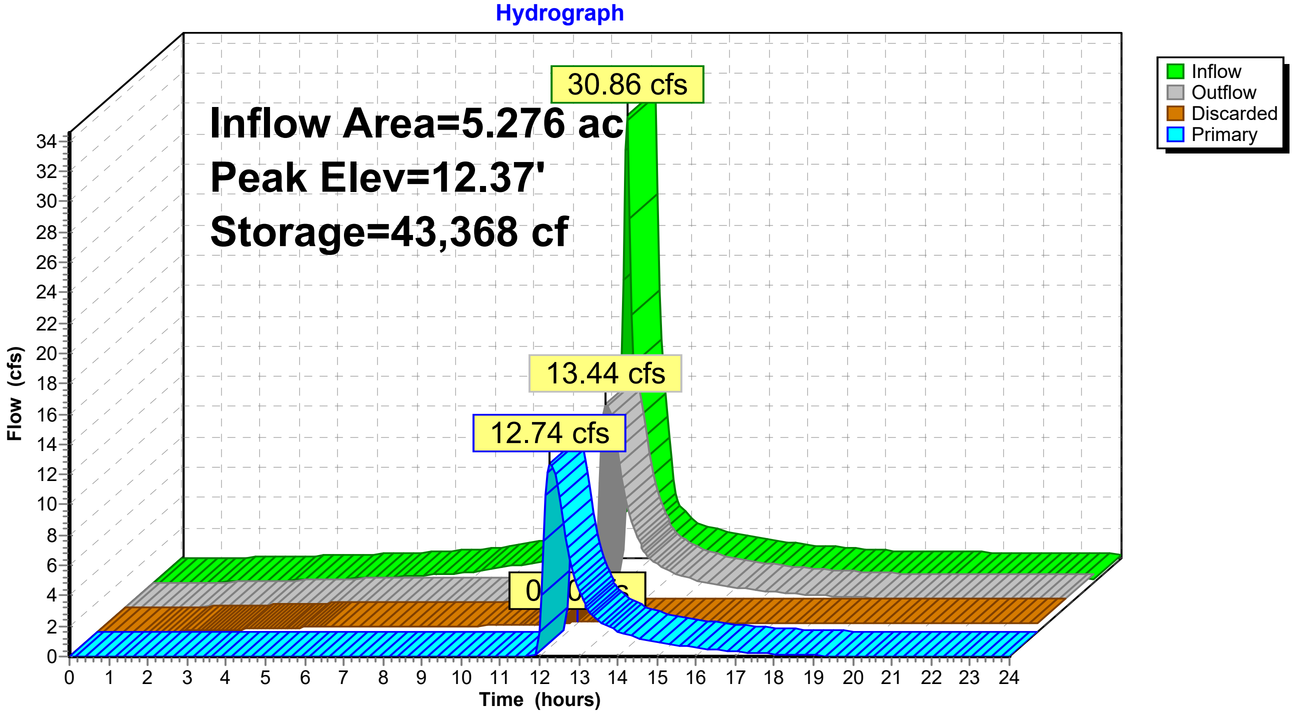
84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone



Pond SSI-2: Subsurface Infiltration System 2



Summary for Pond SSI-3: Subsurface Infiltration System 3

Inflow Area = 3.578 ac, 82.30% Impervious, Inflow Depth > 5.15" for 25-Year Cornell event
Inflow = 19.93 cfs @ 12.09 hrs, Volume= 1.535 af
Outflow = 0.60 cfs @ 15.95 hrs, Volume= 0.712 af, Atten= 97%, Lag= 231.5 min
Discarded = 0.60 cfs @ 15.95 hrs, Volume= 0.712 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 16.97' @ 15.95 hrs Surf.Area= 10,266 sf Storage= 43,556 cf

Plug-Flow detention time= 319.0 min calculated for 0.710 af (46% of inflow)
Center-of-Mass det. time= 199.5 min (979.1 - 779.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	11.00'	21,584 cf	**87.00'W x 118.00'L x 10.00'H Field A** 102,660 cf Overall - 48,699 cf Embedded = 53,961 cf x 40.0% Voids
#2A	12.00'	48,699 cf	**CMP_Round 96** x 8 Inside #1 Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf Overall Size= 96.0"W x 96.0"H x 20.00'L Row Length Adjustment= +80.00' x 50.20 sf x 8 rows 85.00' Header x 50.20 sf x 2 = 8,534.8 cf Inside
		70,283 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	11.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 7.00'

Discarded OutFlow Max=0.60 cfs @ 15.95 hrs HW=16.97' (Free Discharge)
└─**1=Exfiltration** (Controls 0.60 cfs)

Pond SSI-3: Subsurface Infiltration System 3 - Chamber Wizard Field A

Chamber Model = CMP_Round 96 (Round Corrugated Metal Pipe)
Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf
Overall Size= 96.0"W x 96.0"H x 20.00'L
Row Length Adjustment= +80.00' x 50.20 sf x 8 rows

96.0" Wide + 36.0" Spacing = 132.0" C-C Row Spacing

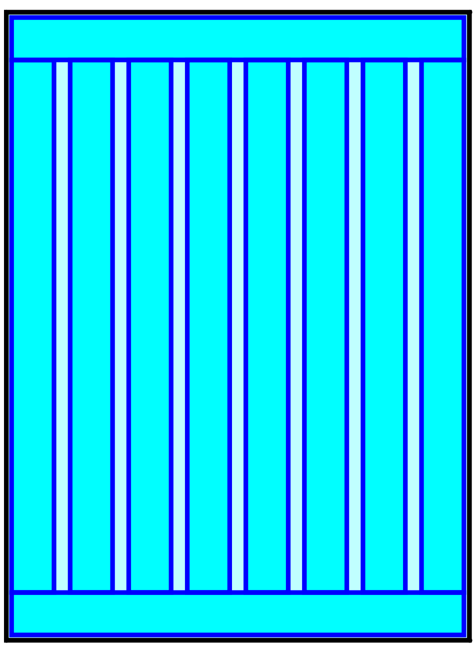
1 Chambers/Row x 20.00' Long +80.00' Row Adjustment +8.00' Header x 2 = 116.00' Row Length +12.0" End Stone x 2 = 118.00' Base Length
8 Rows x 96.0" Wide + 36.0" Spacing x 7 + 12.0" Side Stone x 2 = 87.00' Base Width
12.0" Base + 96.0" Chamber Height + 12.0" Cover = 10.00' Field Height

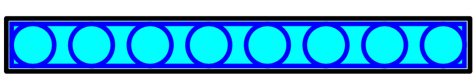
8 Chambers x 1,004.1 cf +80.00' Row Adjustment x 50.20 sf x 8 Rows + 85.00' Header x 50.20 sf x 2 = 48,698.8 cf Chamber Storage

102,660.0 cf Field - 48,698.8 cf Chambers = 53,961.1 cf Stone x 40.0% Voids = 21,584.5 cf Stone Storage

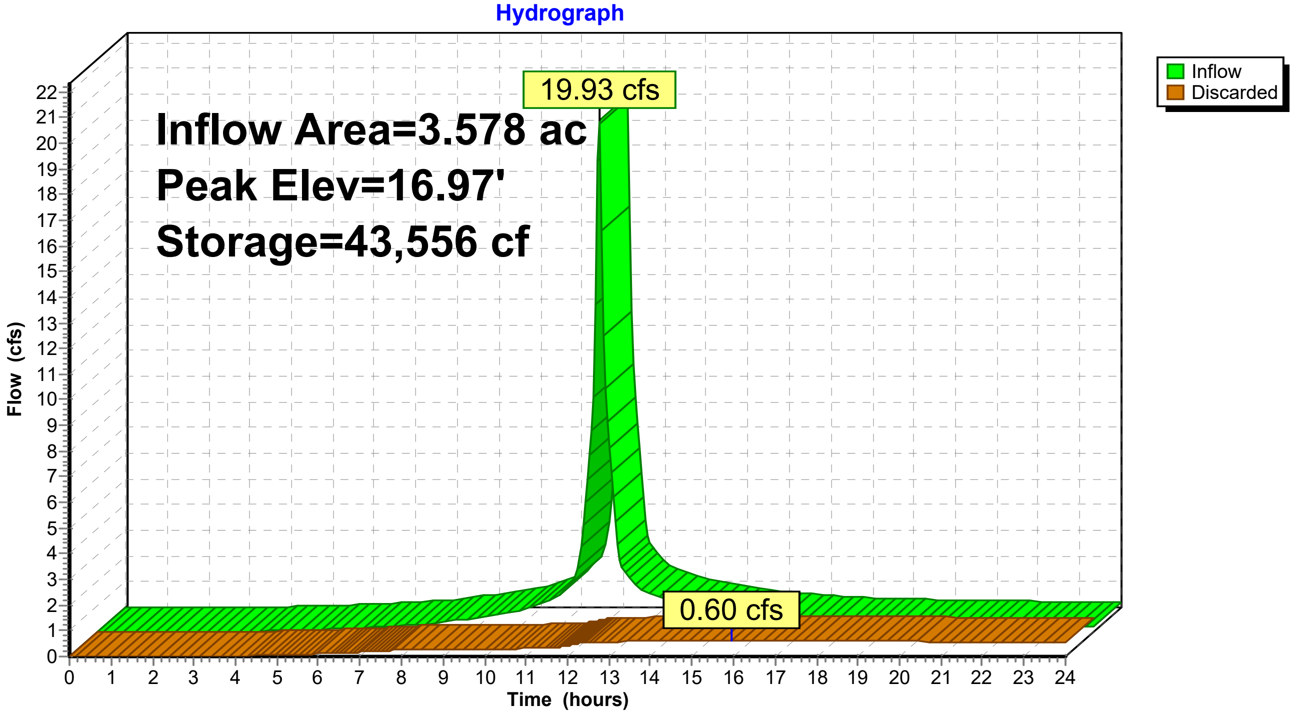
Chamber Storage + Stone Storage = 70,283.3 cf = 1.613 af
Overall Storage Efficiency = 68.5%

8 Chambers
3,802.2 cy Field
1,998.6 cy Stone





Pond SSI-3: Subsurface Infiltration System 3

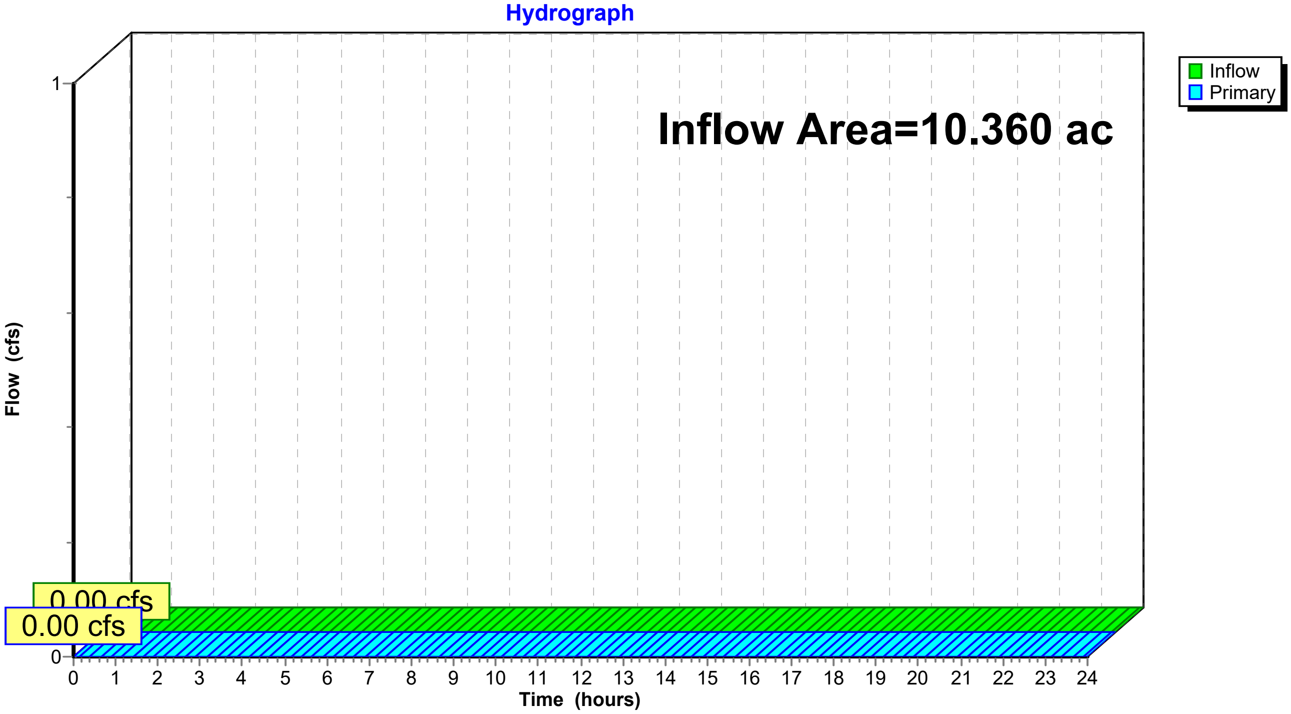


Summary for Link POA-1: 30" Pipe

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth = 0.00" for 25-Year Cornell event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-1: 30" Pipe

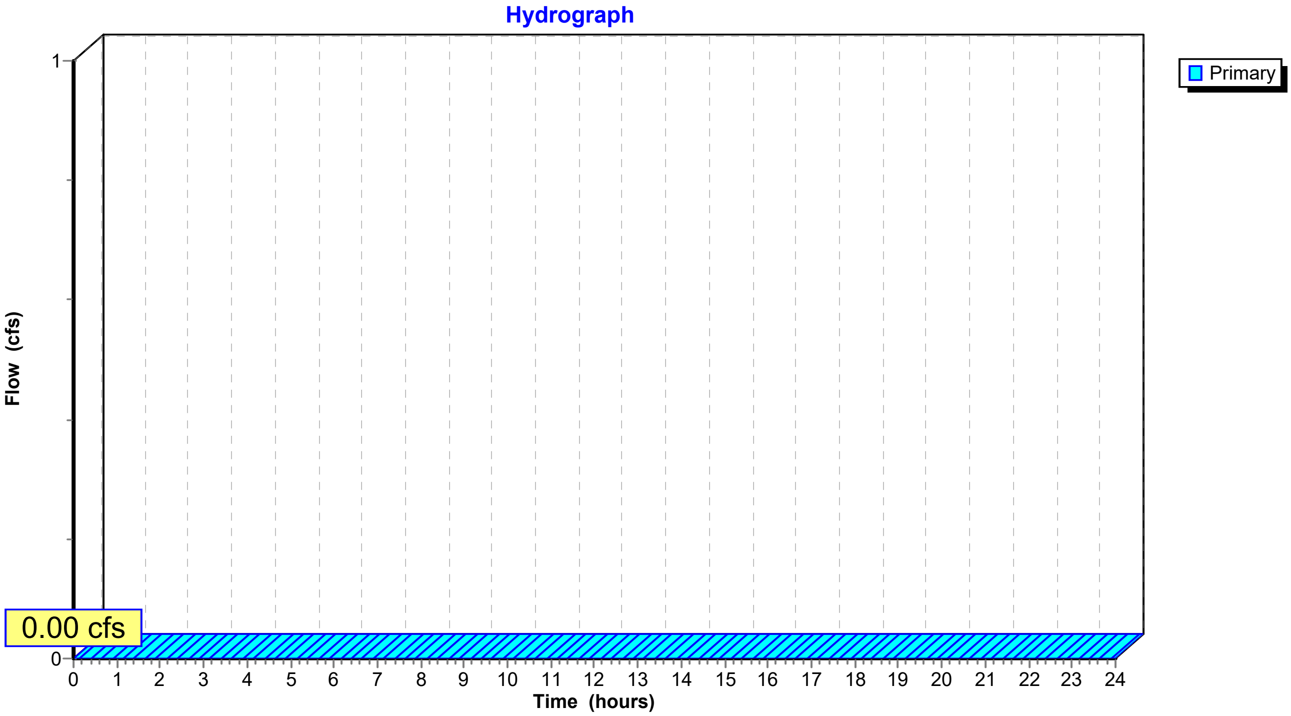


Summary for Link POA-2: 15" Pipe

Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-2: 15" Pipe

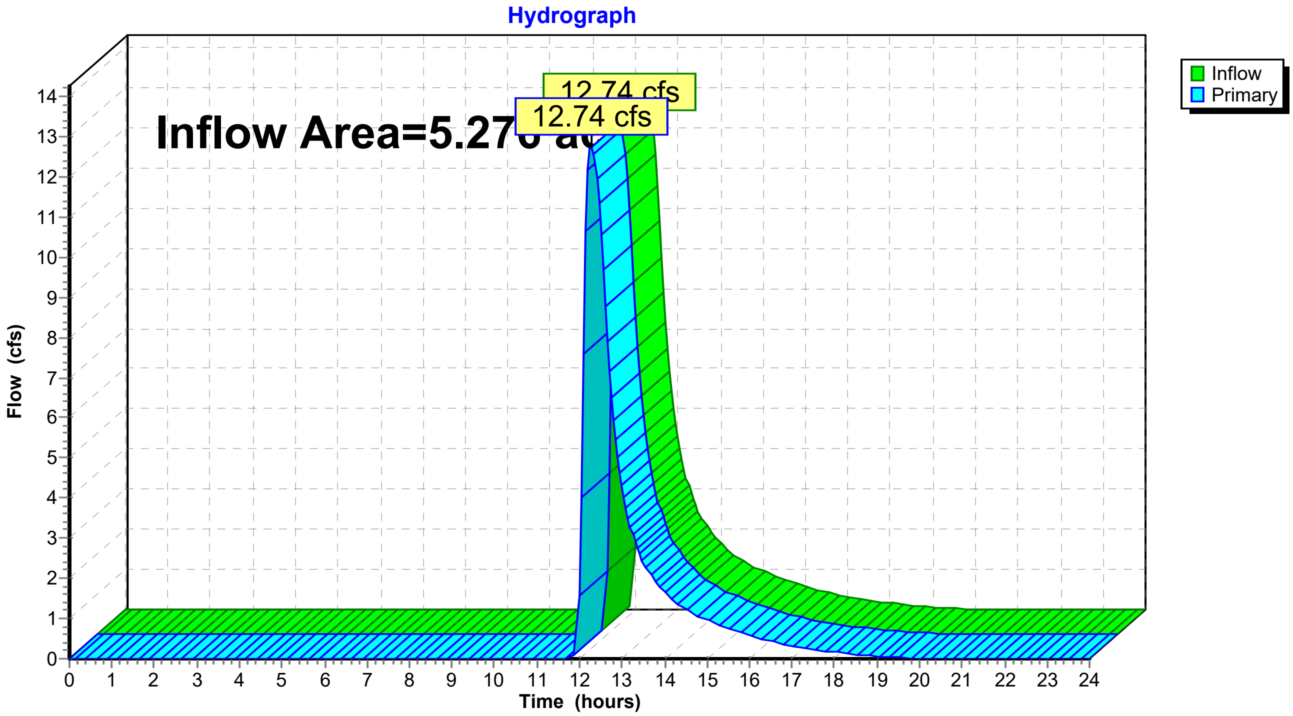


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth = 2.63" for 25-Year Cornell event
Inflow = 12.74 cfs @ 12.28 hrs, Volume= 1.158 af
Primary = 12.74 cfs @ 12.28 hrs, Volume= 1.158 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment HDPR-3B: HD Parking Lot Runoff Area=66,885 sf 87.83% Impervious Runoff Depth>8.05"
Tc=6.0 min CN=93 Runoff=12.84 cfs 1.030 af

Subcatchment PR-1A: North Portion of Runoff Area=393,607 sf 96.73% Impervious Runoff Depth>8.41"
Tc=6.0 min CN=96 Runoff=76.69 cfs 6.335 af

Subcatchment PR-1B: HVMA Lot Runoff Area=155,841 sf 82.30% Impervious Runoff Depth>7.81"
Tc=6.0 min CN=91 Runoff=29.50 cfs 2.328 af

Subcatchment PR-2: South Portion of Lot Runoff Area=57,681 sf 83.32% Impervious Runoff Depth>7.93"
Tc=6.0 min CN=92 Runoff=11.00 cfs 0.875 af

Subcatchment PR-3A: East Portion of Lot Runoff Area=162,941 sf 96.59% Impervious Runoff Depth>8.53"
Tc=6.0 min CN=97 Runoff=31.85 cfs 2.660 af

Pond SSI-1: Subsurface Infiltration Peak Elev=23.66' Storage=119,101 cf Inflow=87.69 cfs 7.211 af
Discarded=10.98 cfs 7.038 af Primary=4.28 cfs 0.168 af Outflow=15.26 cfs 7.206 af

Pond SSI-2: Subsurface Infiltration System Peak Elev=13.95' Storage=56,105 cf Inflow=44.69 cfs 3.690 af
Discarded=0.83 cfs 0.916 af Primary=21.26 cfs 2.208 af Outflow=22.09 cfs 3.123 af

Pond SSI-3: Subsurface Infiltration System Peak Elev=20.73' Storage=69,181 cf Inflow=29.50 cfs 2.328 af
Outflow=0.83 cfs 0.956 af

Link POA-1: 30" Pipe Inflow=4.28 cfs 0.168 af
Primary=4.28 cfs 0.168 af

Link POA-2: 15" Pipe
Primary=0.00 cfs 0.000 af

Link POA-3: 18" Pipe and 24" Pipe Inflow=21.26 cfs 2.208 af
Primary=21.26 cfs 2.208 af

Total Runoff Area = 19.214 ac Runoff Volume = 13.229 af Average Runoff Depth = 8.26"
7.62% Pervious = 1.464 ac 92.38% Impervious = 17.749 ac

Summary for Subcatchment HDPR-3B: HD Parking Lot

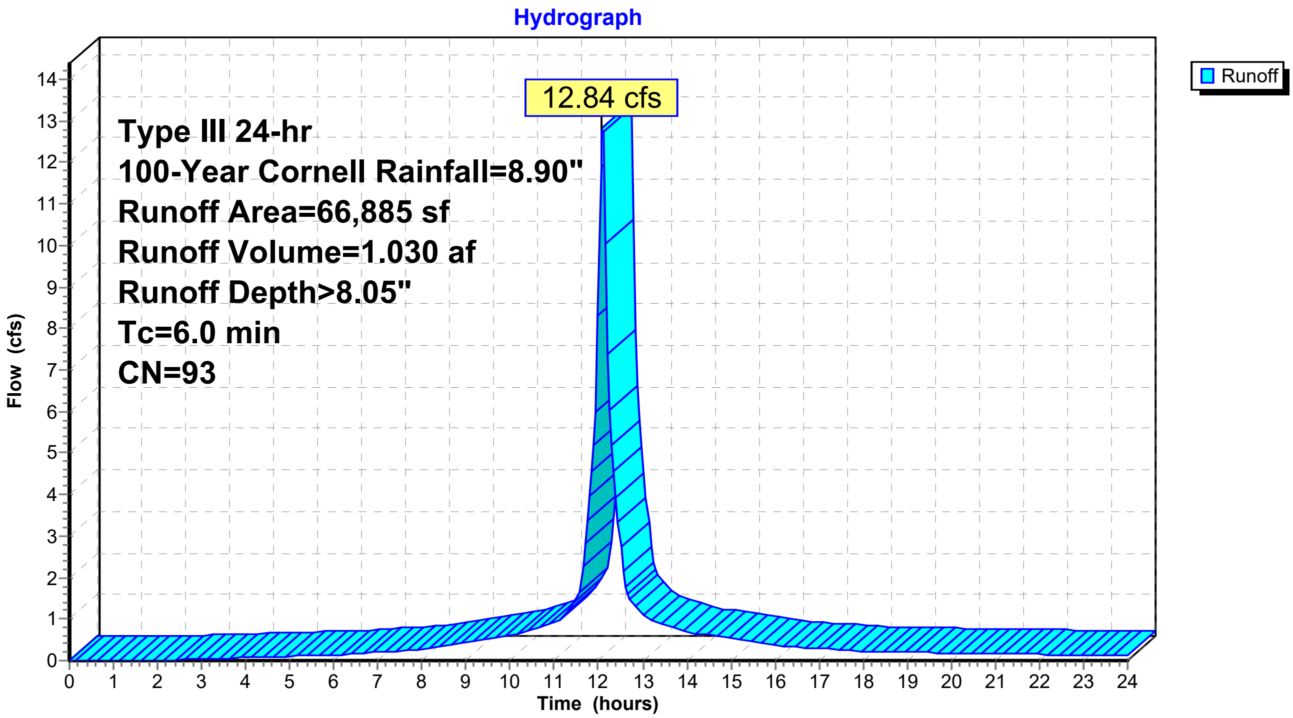
Runoff = 12.84 cfs @ 12.09 hrs, Volume= 1.030 af, Depth> 8.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
8,139	61	>75% Grass cover, Good, HSG B
58,746	98	Paved parking, HSG B
66,885	93	Weighted Average
8,139		12.17% Pervious Area
58,746		87.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment HDPR-3B: HD Parking Lot



Summary for Subcatchment PR-1A: North Portion of Lot

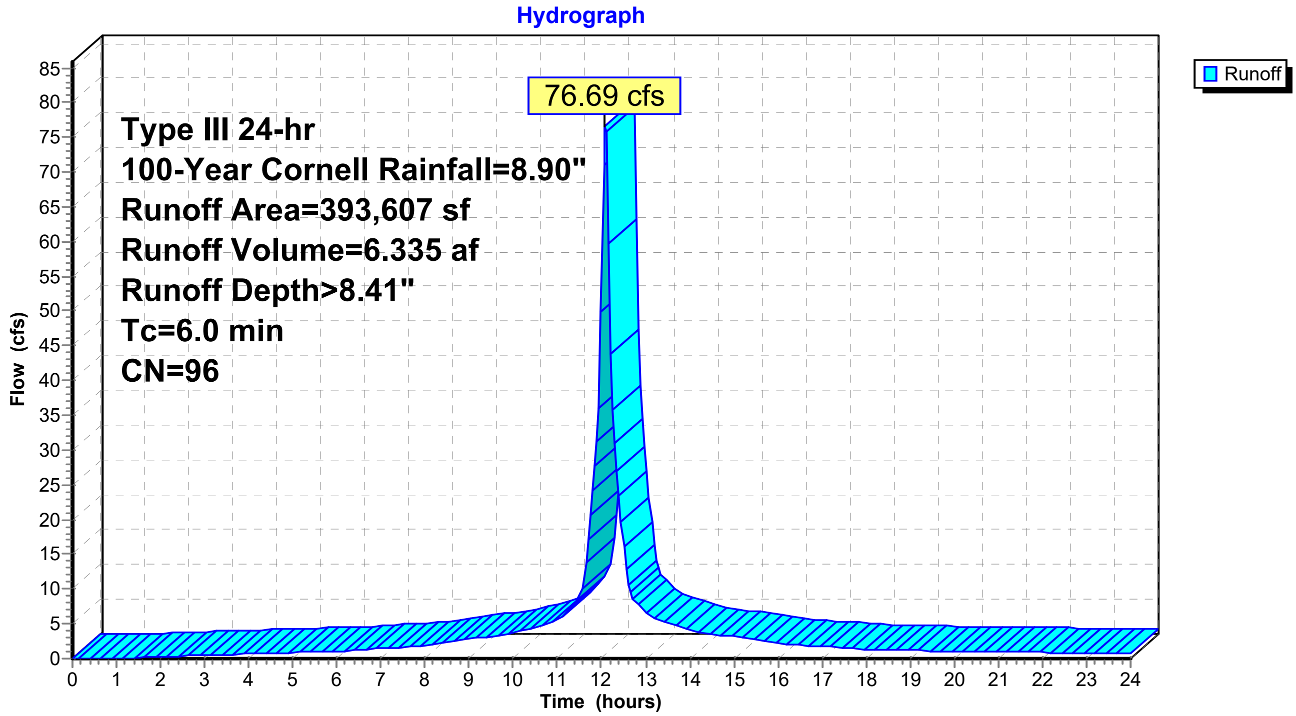
Runoff = 76.69 cfs @ 12.09 hrs, Volume= 6.335 af, Depth> 8.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
12,883	39	>75% Grass cover, Good, HSG A
174,583	98	Roofs, HSG A
206,141	98	Paved parking, HSG A
393,607	96	Weighted Average
12,883		3.27% Pervious Area
380,724		96.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1A: North Portion of Lot



Summary for Subcatchment PR-1B: HVMA Lot

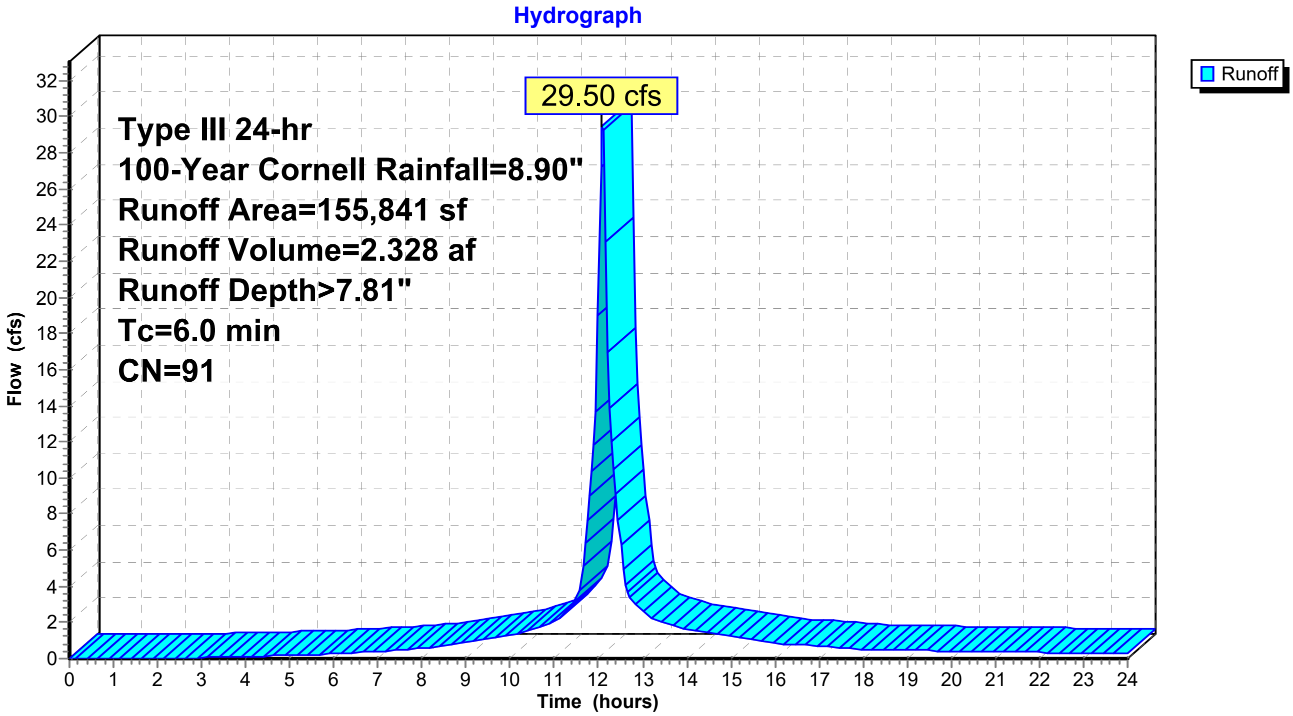
Runoff = 29.50 cfs @ 12.09 hrs, Volume= 2.328 af, Depth> 7.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
27,588	61	>75% Grass cover, Good, HSG B
18,625	98	Roofs, HSG B
109,628	98	Paved parking, HSG B
155,841	91	Weighted Average
27,588		17.70% Pervious Area
128,253		82.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-1B: HVMA Lot



Summary for Subcatchment PR-2: South Portion of Lot

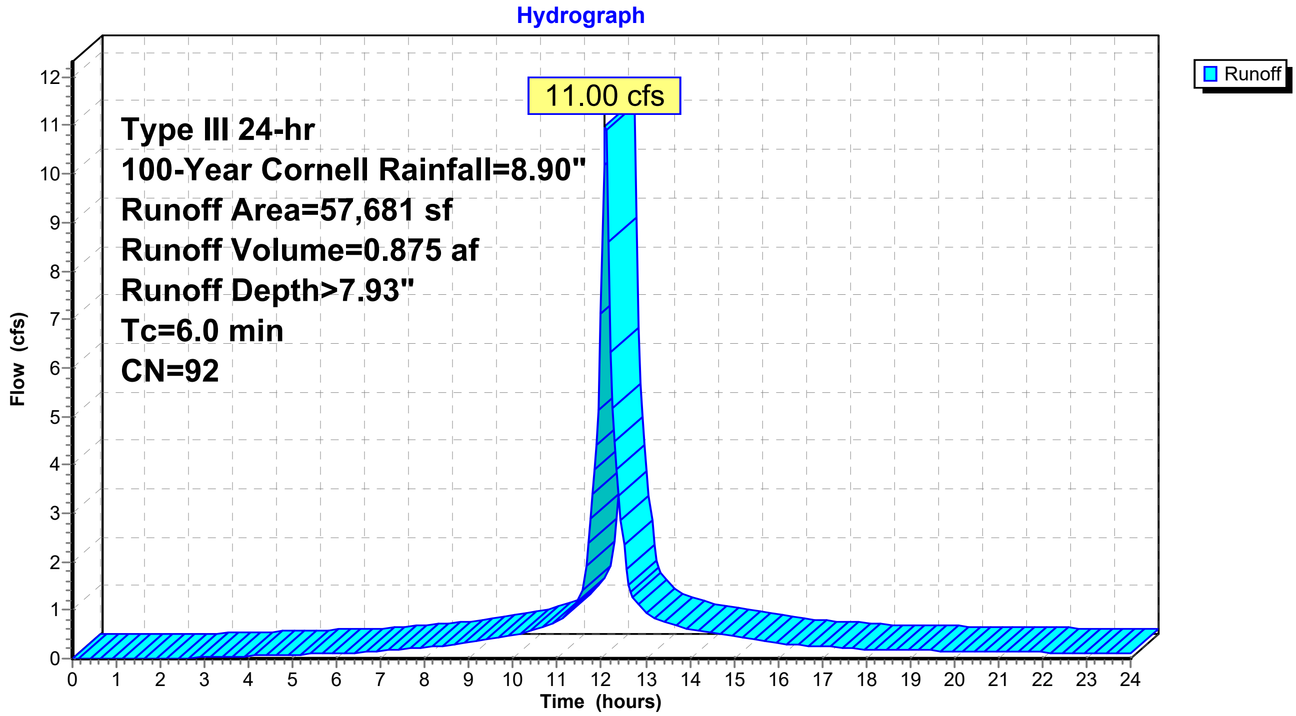
Runoff = 11.00 cfs @ 12.09 hrs, Volume= 0.875 af, Depth> 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
9,621	61	>75% Grass cover, Good, HSG B
40,578	98	Roofs, HSG B
7,482	98	Paved parking, HSG B
57,681	92	Weighted Average
9,621		16.68% Pervious Area
48,060		83.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-2: South Portion of Lot



Summary for Subcatchment PR-3A: East Portion of Lot

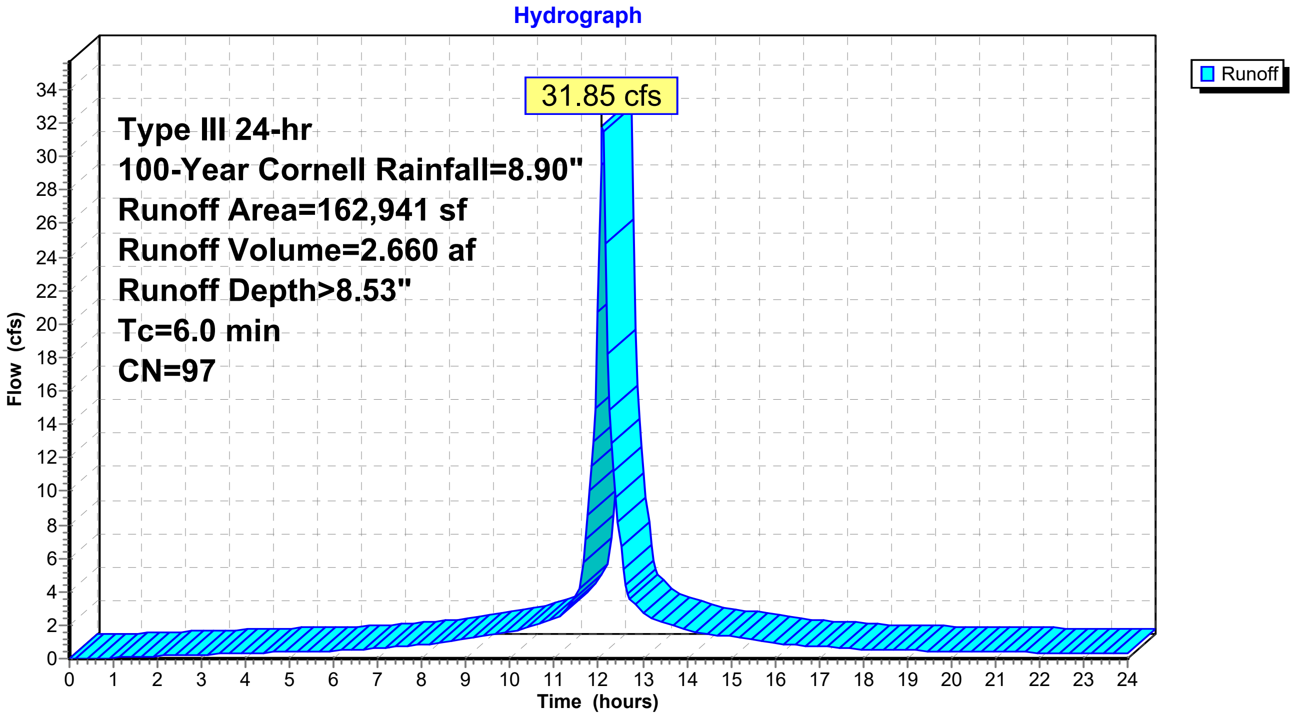
Runoff = 31.85 cfs @ 12.09 hrs, Volume= 2.660 af, Depth> 8.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Cornell Rainfall=8.90"

Area (sf)	CN	Description
5,559	61	>75% Grass cover, Good, HSG B
67,368	98	Roofs, HSG B
90,014	98	Paved parking, HSG B
162,941	97	Weighted Average
5,559		3.41% Pervious Area
157,382		96.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Direct Entry**

Subcatchment PR-3A: East Portion of Lot



Summary for Pond SSI-1: Subsurface Infiltration System 1

Inflow Area = 10.360 ac, 95.01% Impervious, Inflow Depth > 8.35" for 100-Year Cornell event
Inflow = 87.69 cfs @ 12.09 hrs, Volume= 7.211 af
Outflow = 15.26 cfs @ 12.55 hrs, Volume= 7.206 af, Atten= 83%, Lag= 27.6 min
Discarded = 10.98 cfs @ 12.55 hrs, Volume= 7.038 af
Primary = 4.28 cfs @ 12.55 hrs, Volume= 0.168 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 23.66' @ 12.55 hrs Surf.Area= 14,652 sf Storage= 119,101 cf

Plug-Flow detention time= 100.3 min calculated for 7.191 af (100% of inflow)
Center-of-Mass det. time= 99.7 min (851.6 - 751.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	12.00'	40,931 cf	**66.00'W x 222.00'L x 13.00'H Field A**
			190,476 cf Overall - 88,150 cf Embedded = 102,326 cf x 40.0% Voids
#2A	14.50'	88,150 cf	**CMP_Round 120** x 5 Inside #1
			Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
			Overall Size= 120.0"W x 120.0"H x 20.00'L
			Row Length Adjustment= +180.00' x 78.43 sf x 5 rows
			62.00' Header x 78.43 sf x 2 = 9,724.7 cf Inside
		129,080 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	22.50'	**24.0" Round Culvert**
			L= 10.0' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 22.50' / 22.45' S= 0.0050 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#2	Discarded	12.00'	**8.270 in/hr Exfiltration over Surface area**
			Conductivity to Groundwater Elevation = 8.00'

Discarded OutFlow Max=10.98 cfs @ 12.55 hrs HW=23.66' (Free Discharge)
↑—**2=Exfiltration** (Controls 10.98 cfs)

Primary OutFlow Max=4.27 cfs @ 12.55 hrs HW=23.66' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 4.27 cfs @ 3.27 fps)

Pond SSI-1: Subsurface Infiltration System 1 - Chamber Wizard Field A

Chamber Model = CMP_Round 120 (Round Corrugated Metal Pipe)
Effective Size= 120.0"W x 120.0"H => 78.43 sf x 20.00'L = 1,568.5 cf
Overall Size= 120.0"W x 120.0"H x 20.00'L
Row Length Adjustment= +180.00' x 78.43 sf x 5 rows

120.0" Wide + 36.0" Spacing = 156.0" C-C Row Spacing

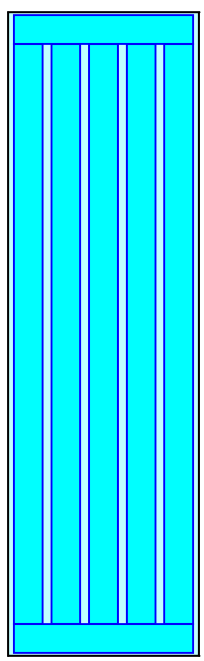
1 Chambers/Row x 20.00' Long +180.00' Row Adjustment +10.00' Header x 2 = 220.00' Row Length
+12.0" End Stone x 2 = 222.00' Base Length
5 Rows x 120.0" Wide + 36.0" Spacing x 4 + 24.0" Side Stone x 2 = 66.00' Base Width
30.0" Base + 120.0" Chamber Height + 6.0" Cover = 13.00' Field Height

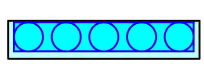
5 Chambers x 1,568.5 cf +180.00' Row Adjustment x 78.43 sf x 5 Rows + 62.00' Header x 78.43 sf x 2 = 88,149.7 cf Chamber Storage

190,476.0 cf Field - 88,149.7 cf Chambers = 102,326.3 cf Stone x 40.0% Voids = 40,930.5 cf Stone Storage

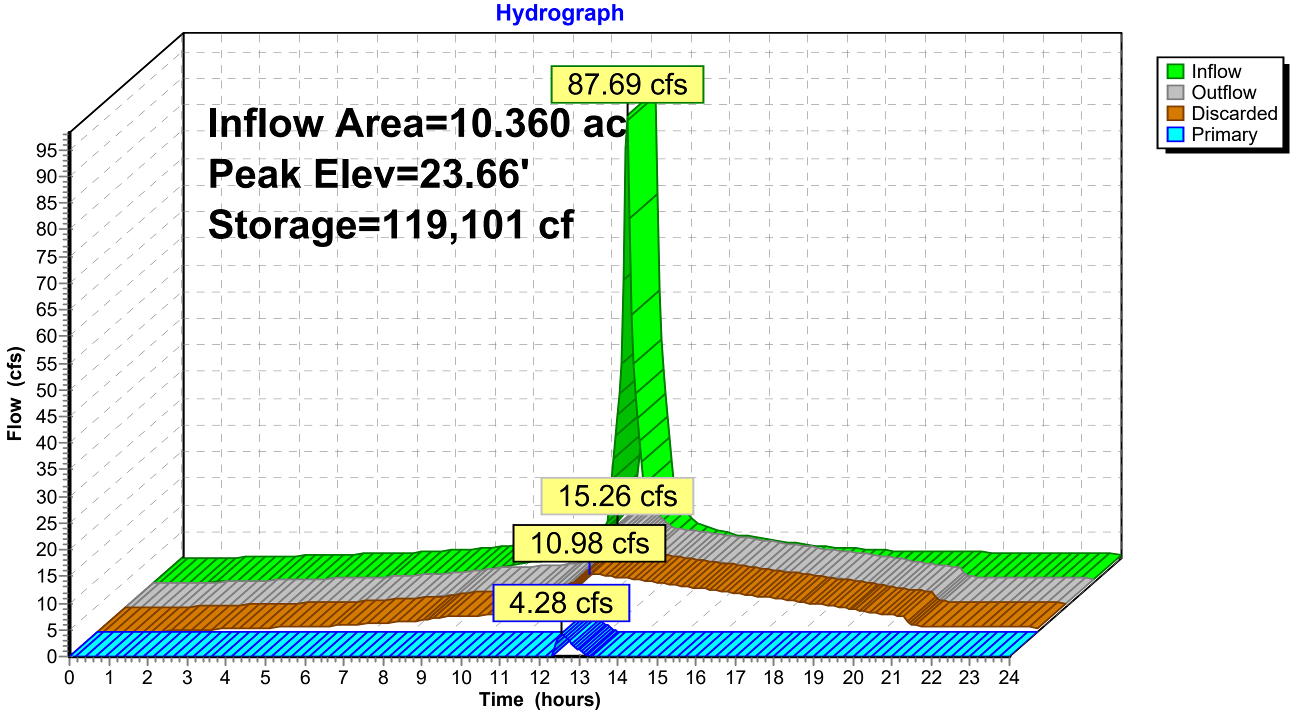
Chamber Storage + Stone Storage = 129,080.2 cf = 2.963 af
Overall Storage Efficiency = 67.8%

5 Chambers
7,054.7 cy Field
3,789.9 cy Stone





Pond SSI-1: Subsurface Infiltration System 1



Summary for Pond SSI-2: Subsurface Infiltration System 2

Inflow Area = 5.276 ac, 94.04% Impervious, Inflow Depth > 8.39" for 100-Year Cornell event
Inflow = 44.69 cfs @ 12.09 hrs, Volume= 3.690 af
Outflow = 22.09 cfs @ 12.24 hrs, Volume= 3.123 af, Atten= 51%, Lag= 9.3 min
Discarded = 0.83 cfs @ 12.24 hrs, Volume= 0.916 af
Primary = 21.26 cfs @ 12.24 hrs, Volume= 2.208 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 13.95' @ 12.24 hrs Surf.Area= 14,107 sf Storage= 56,105 cf

Plug-Flow detention time= 126.5 min calculated for 3.117 af (84% of inflow)
Center-of-Mass det. time= 61.6 min (811.5 - 749.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	8.00'	18,850 cf	**44.50'W x 317.00'L x 6.00'H Field A** 84,639 cf Overall - 37,515 cf Embedded = 47,124 cf x 40.0% Voids
#2A	8.50'	37,515 cf	**CMP_Round 60** x 6 Inside #1 Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf Overall Size= 60.0"W x 60.0"H x 20.00'L Row Length Adjustment= +285.00' x 19.59 sf x 6 rows 42.50' Header x 19.59 sf x 2 = 1,665.2 cf Inside
		56,365 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Primary	10.70'	**18.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 10.70' / 10.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Discarded	8.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 4.00'

Discarded OutFlow Max=0.83 cfs @ 12.24 hrs HW=13.95' (Free Discharge)
└─**3=Exfiltration** (Controls 0.83 cfs)

Primary OutFlow Max=21.23 cfs @ 12.24 hrs HW=13.95' (Free Discharge)
├─**1=Culvert** (Inlet Controls 10.61 cfs @ 6.01 fps)
└─**2=Culvert** (Inlet Controls 10.61 cfs @ 6.01 fps)

Pond SSI-2: Subsurface Infiltration System 2 - Chamber Wizard Field A

Chamber Model = CMP_Round 60 (Round Corrugated Metal Pipe)
Effective Size= 60.0"W x 60.0"H => 19.59 sf x 20.00'L = 391.8 cf
Overall Size= 60.0"W x 60.0"H x 20.00'L
Row Length Adjustment= +285.00' x 19.59 sf x 6 rows

60.0" Wide + 30.0" Spacing = 90.0" C-C Row Spacing

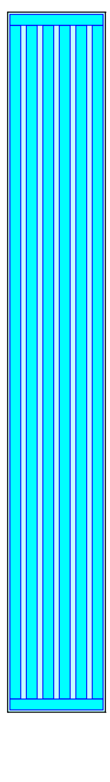
1 Chambers/Row x 20.00' Long +285.00' Row Adjustment +5.00' Header x 2 = 315.00' Row Length
+12.0" End Stone x 2 = 317.00' Base Length
6 Rows x 60.0" Wide + 30.0" Spacing x 5 + 12.0" Side Stone x 2 = 44.50' Base Width
6.0" Base + 60.0" Chamber Height + 6.0" Cover = 6.00' Field Height

6 Chambers x 391.8 cf +285.00' Row Adjustment x 19.59 sf x 6 Rows + 42.50' Header x 19.59 sf x 2 =
37,514.9 cf Chamber Storage

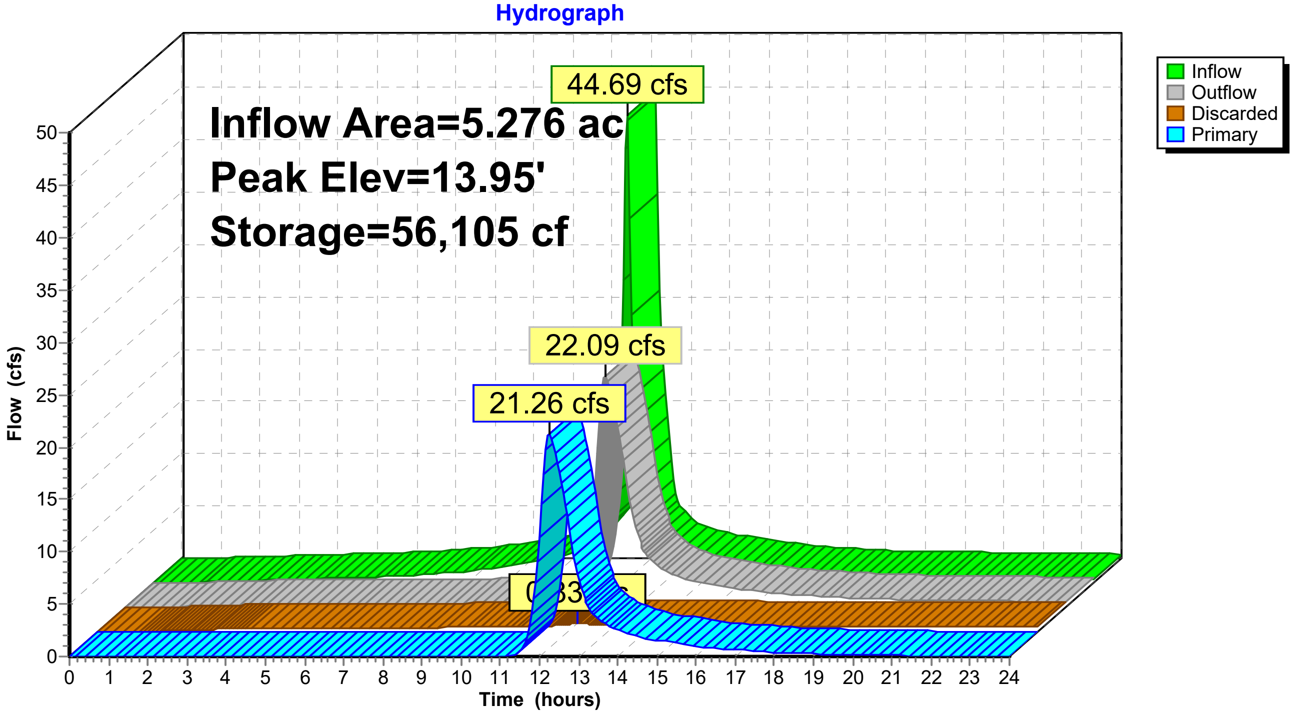
84,639.0 cf Field - 37,514.9 cf Chambers = 47,124.1 cf Stone x 40.0% Voids = 18,849.7 cf Stone Storage

Chamber Storage + Stone Storage = 56,364.5 cf = 1.294 af
Overall Storage Efficiency = 66.6%

6 Chambers
3,134.8 cy Field
1,745.3 cy Stone



Pond SSI-2: Subsurface Infiltration System 2



Summary for Pond SSI-3: Subsurface Infiltration System 3

Inflow Area = 3.578 ac, 82.30% Impervious, Inflow Depth > 7.81" for 100-Year Cornell event
Inflow = 29.50 cfs @ 12.09 hrs, Volume= 2.328 af
Outflow = 0.83 cfs @ 16.08 hrs, Volume= 0.956 af, Atten= 97%, Lag= 239.5 min
Discarded = 0.83 cfs @ 16.08 hrs, Volume= 0.956 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 20.73' @ 16.08 hrs Surf.Area= 10,266 sf Storage= 69,181 cf

Plug-Flow detention time= 337.4 min calculated for 0.954 af (41% of inflow)
Center-of-Mass det. time= 203.1 min (972.3 - 769.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	11.00'	21,584 cf	**87.00'W x 118.00'L x 10.00'H Field A** 102,660 cf Overall - 48,699 cf Embedded = 53,961 cf x 40.0% Voids
#2A	12.00'	48,699 cf	**CMP_Round 96** x 8 Inside #1 Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf Overall Size= 96.0"W x 96.0"H x 20.00'L Row Length Adjustment= +80.00' x 50.20 sf x 8 rows 85.00' Header x 50.20 sf x 2 = 8,534.8 cf Inside
		70,283 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	11.00'	**1.020 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 7.00'

Discarded OutFlow Max=0.83 cfs @ 16.08 hrs HW=20.73' (Free Discharge)
└─**1=Exfiltration** (Controls 0.83 cfs)

Pond SSI-3: Subsurface Infiltration System 3 - Chamber Wizard Field A

Chamber Model = CMP_Round 96 (Round Corrugated Metal Pipe)
Effective Size= 96.0"W x 96.0"H => 50.20 sf x 20.00'L = 1,004.1 cf
Overall Size= 96.0"W x 96.0"H x 20.00'L
Row Length Adjustment= +80.00' x 50.20 sf x 8 rows

96.0" Wide + 36.0" Spacing = 132.0" C-C Row Spacing

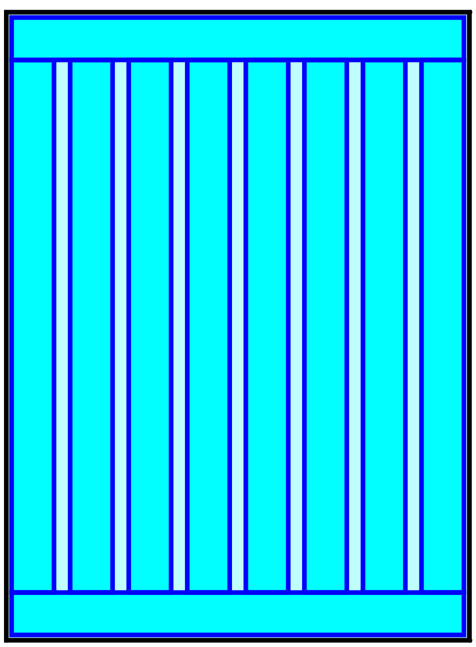
1 Chambers/Row x 20.00' Long +80.00' Row Adjustment +8.00' Header x 2 = 116.00' Row Length +12.0" End Stone x 2 = 118.00' Base Length
8 Rows x 96.0" Wide + 36.0" Spacing x 7 + 12.0" Side Stone x 2 = 87.00' Base Width
12.0" Base + 96.0" Chamber Height + 12.0" Cover = 10.00' Field Height

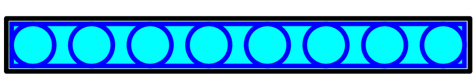
8 Chambers x 1,004.1 cf +80.00' Row Adjustment x 50.20 sf x 8 Rows + 85.00' Header x 50.20 sf x 2 = 48,698.8 cf Chamber Storage

102,660.0 cf Field - 48,698.8 cf Chambers = 53,961.1 cf Stone x 40.0% Voids = 21,584.5 cf Stone Storage

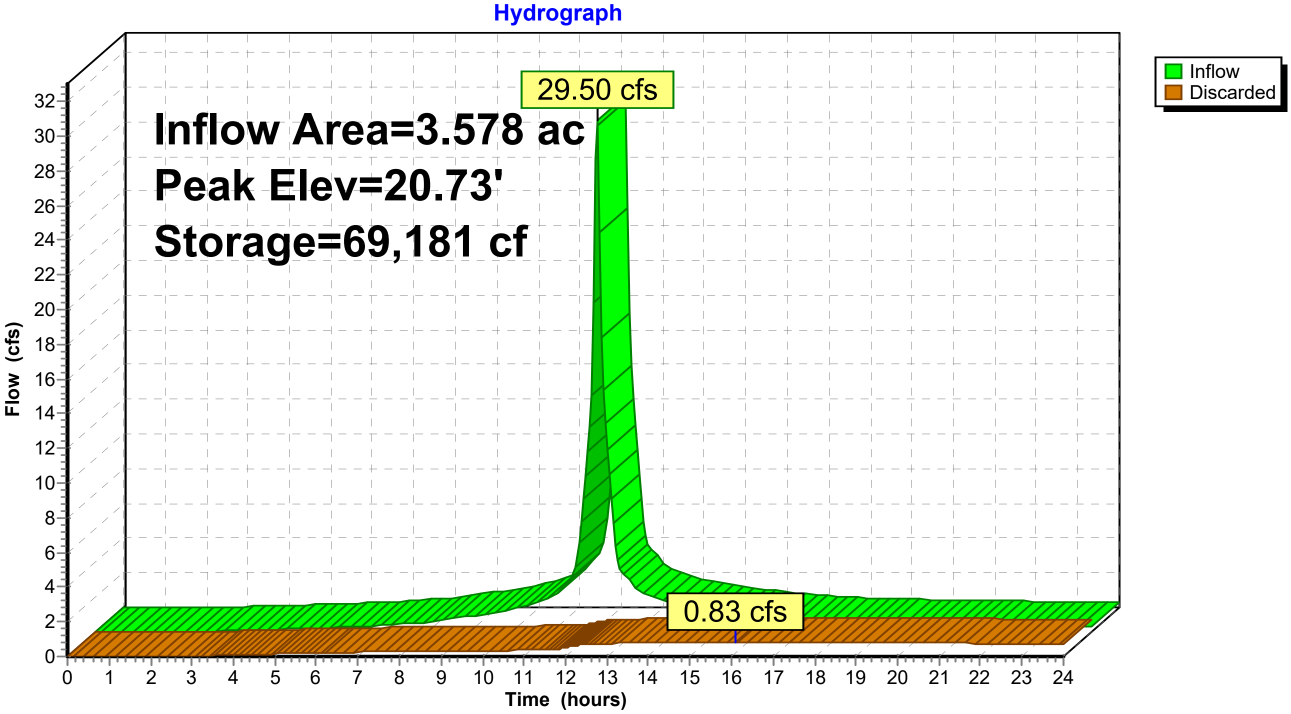
Chamber Storage + Stone Storage = 70,283.3 cf = 1.613 af
Overall Storage Efficiency = 68.5%

8 Chambers
3,802.2 cy Field
1,998.6 cy Stone





Pond SSI-3: Subsurface Infiltration System 3

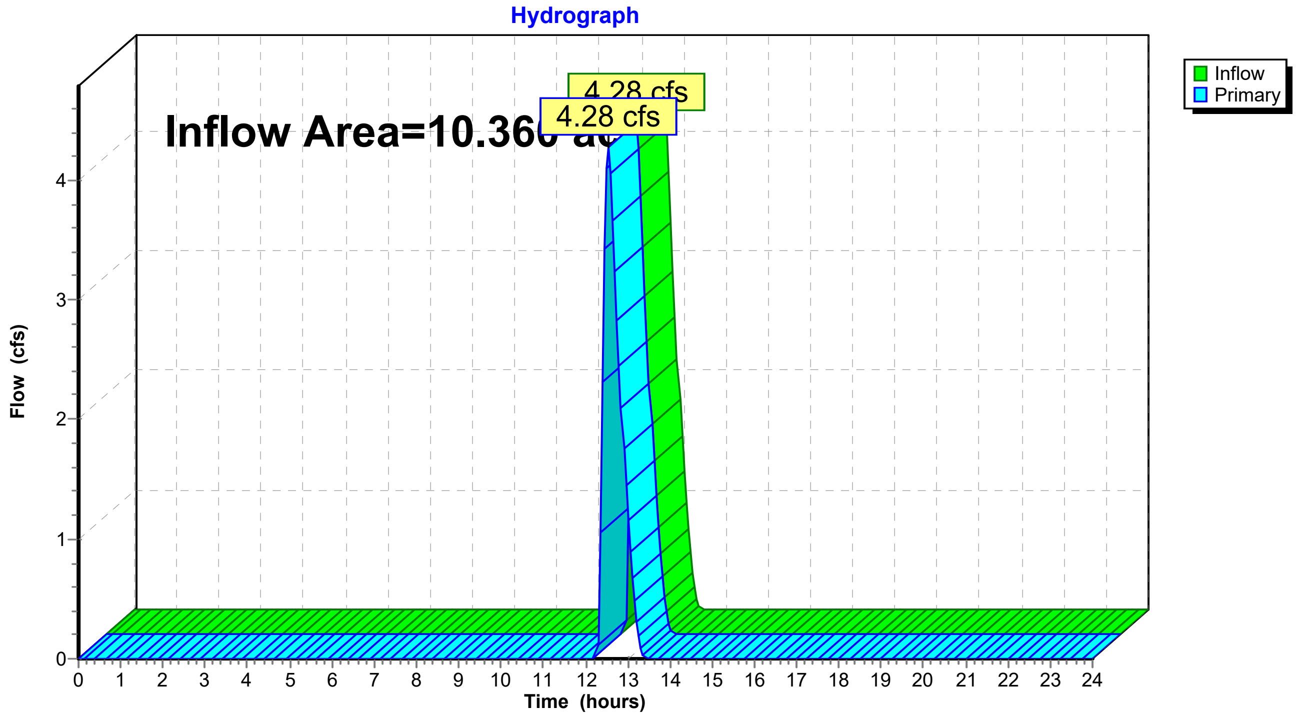


Summary for Link POA-1: 30" Pipe

Inflow Area =	10.360 ac,	95.01% Impervious,	Inflow Depth = 0.19"	for 100-Year Cornell event
Inflow =	4.28 cfs @	12.55 hrs, Volume=	0.168 af	
Primary =	4.28 cfs @	12.55 hrs, Volume=	0.168 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

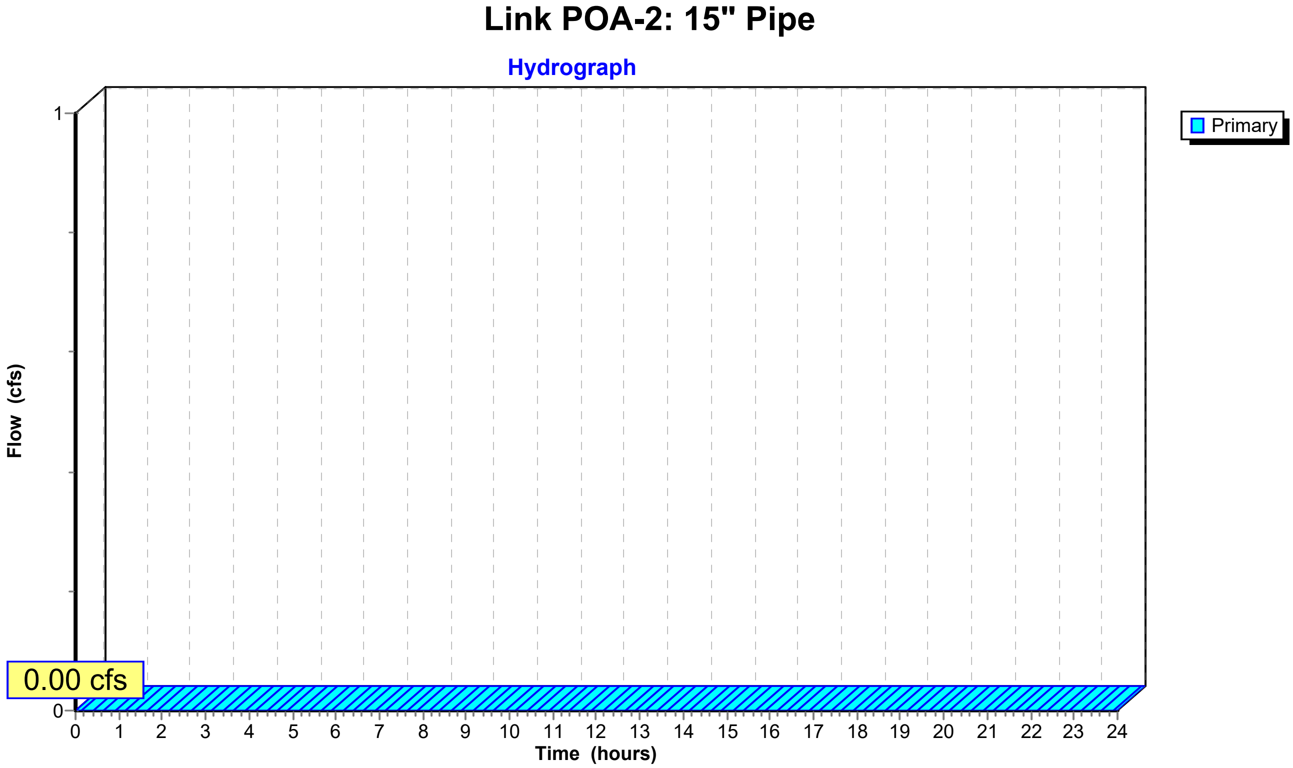
Link POA-1: 30" Pipe



Summary for Link POA-2: 15" Pipe

Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

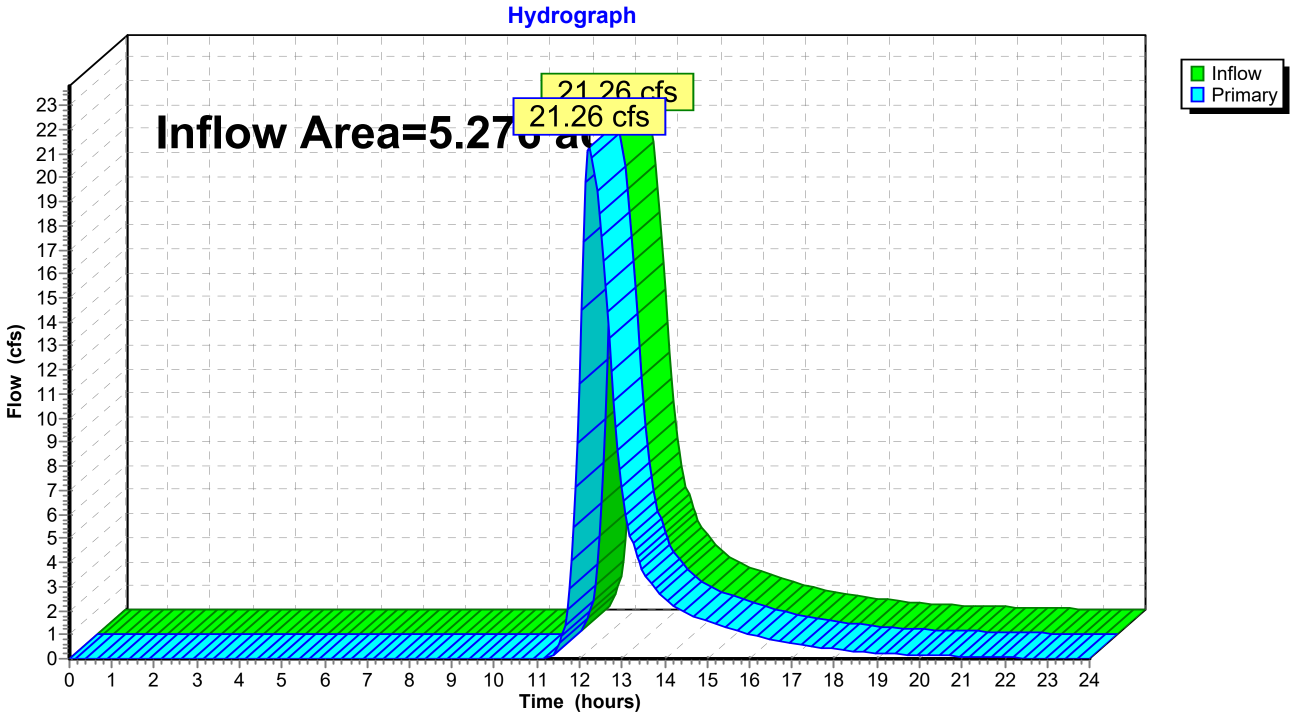


Summary for Link POA-3: 18" Pipe and 24" Pipe

Inflow Area =	5.276 ac,	94.04% Impervious,	Inflow Depth = 5.02"	for 100-Year Cornell event	
Inflow =	21.26 cfs @	12.24 hrs,	Volume=	2.208 af	
Primary =	21.26 cfs @	12.24 hrs,	Volume=	2.208 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA-3: 18" Pipe and 24" Pipe



III. APPENDIX E

Performance Data

Table TSS

TSS Removal Efficiencies for Best Management Practices	
Best Management Practice (BMP)	**TSS Removal Efficiency**
Non-Structural Pretreatment BMPs	
Street Sweeping	0-10%, See Volume 2, Chapter 1.
Structural Pretreatment BMPs	
Deep Sump Catch Basins	25% only if used for pretreatment and only if off-line
Oil Grit Separator	25% only if used for pretreatment and only if off-line
Proprietary Separators	Varies – see Volume 2, Chapter 4.
Sediment Forebays	25% if used for pretreatment
Vegetated filter strips	10% if at least 25 feet wide, 45% if at least 50 feet wide
Treatment BMPs	
Bioretention Areas including rain gardens	90% provided it is combined with adequate pretreatment
Constructed Stormwater Wetlands	80% provided it is combined with a sediment forebay
Extended Dry Detention Basins	50% provided it is combined with a sediment forebay
Gravel Wetlands	80% provided it is combined with a sediment forebay
Proprietary Media Filters	Varies – see Volume 2, Chapter 4
Sand/Organic Filters	80% provided it is combined with sediment forebay
Treebox filter	80% provided it is combined with adequate pretreatment
Wet Basins	80% provided it is combined with sediment forebay
Conveyance	
Drainage Channels	For conveyance only. No TSS Removal credit.
Grass Channels (formerly biofilter swales)	50% if combined with sediment forebay or equivalent
Water Quality Swale – wet & dry	70% provided it is combined with sediment forebay or equivalent
Infiltration BMPs	
Dry Wells	80% for runoff from non-metal roofs; may also be used for runoff from metal roofs but only if metal roof is not located within a Zone II, or IWPA or at an industrial site
Infiltration Basins & Infiltration Trenches	80% provided it is combined with adequate pretreatment (sediment forebay or vegetated filter strip, grass channel, water quality swale) prior to infiltration
Leaching Catch Basins	80% provided a deep sump catch basin is used for pretreatment
Subsurface Structure	80% provided they are combined with one or more pretreatment BMPs prior to infiltration.
Other BMPs	
Dry Detention Basins	For peak rate attenuation only. No TSS Removal credit.
Green Roofs	See Volume 2. Chapter 2. May reduce required water quality volume. No TSS Removal Credit.
Porous Pavement	80% if designed to prevent runon and with adequate storage capacity. Limited to uses identified in Volume 2, Chapter 2.
Rain Barrels and Cisterns	May reduce required water quality volume. No TSS Removal Credit.

Better Site Design: A Handbook for Changing Development Rules in Your Community; Center for Watershed Protection; 1998. Site Planning for Urban Stream Protection; Thomas Schueler; Center for Watershed Protection; 1995.

Conservation Design for Subdivisions: A Practical Guide for Creating Open Space Networks; Randall Arendt; Island Press; 1996.

"Site Analysis." James A. LaGro, Jr.; John Wiley and Sons; 2001 *An Introduction to Better Site Design*; Article 45 from Watershed Protection Techniques; Center for Watershed Protection; 2000.

B. Nonstructural Approaches: Source Control and Pollution Prevention

Source controls can reduce the types and concentrations of contaminants in stormwater runoff and improve water quality. Source controls cover a wide range of practices including local bylaws and regulations, materials management at industrial sites, fertilizer and pest management in residential areas, reduced road salting in winter, erosion and sediment controls at construction sites, and comprehensive snow management.

Effective site planning is essential to source control and pollution prevention. Reducing impervious surfaces and runoff volumes prevents the transport of pollutants. The guiding principle for pollution prevention is to minimize the volume of runoff and the contact of stormwater with potential pollutants. Because nonstructural practices can reduce stormwater pollutant loads and quantities, the size and expense of structural BMPs (or in rare cases, even the need for structural BMPs) can be reduced, thereby affording substantial cost savings.

The *Massachusetts Nonpoint Pollution Source Management Manual* (http://www.mass.gov/dep/water/resources/nonpoint.htm#megaman) published by MassDEP (2006) provides a detailed summary of the pollutants associated with specific land use activities. These summaries can be used to identify the potential pollutants at a site, so that suitable controls can be implemented.

Street and Parking Lot Sweeping

One effective nonstructural source control is street and parking lot sweeping. Many municipalities and some private entities (e.g., commercial shopping areas or office parks) have street sweeping programs. Although intended to provide important nonpoint source pollution control, many street sweeping programs are not effective at capturing the peak sediment loads.

The NURP study (EPA, 1983) indicates that sweeping streets once a year using rotary brush sweepers resulted in no TSS removal. A study conducted by the USGS (Smith, 2002) along the Southeast Expressway in Boston indicates that sweeping yielded a net increase in sediment, because the road shoulder was not stabilized and contributed more sediment to the Southeast Expressway than the sweepers could remove.

There are many reasons that some street sweeping programs are not effective.

- The period immediately following winter snowmelt, when road sand and other accumulated sediment and debris is washed off, is frequently missed by street sweeping programs.
- Larger particles of street dirt may prevent smaller particles from being collected.
- The entire width of roadway may not be swept.
- Sweepers may be driven too quickly to achieve maximum efficiency.
- Land surfaces along the paved surfaces may not be entirely stabilized.

Other studies have shown that if done properly, street sweeping can be highly effective. Breault 2005 indicates that sweepers can achieve high removal efficiencies. That study assessed total solids removal, and included large particles. Zarriello 2002 verified the effectiveness of high efficiency sweepers.

There are three factors in particular that can have a major influence on the effectiveness of a street sweeping program: **access, the type of sweeper, and the frequency of sweeping**.

Effective sweeping requires access to the areas to be swept. Parked cars impede street sweeping. Studies have shown that up to 95% of the solids on a paved surface accumulate within 40 inches of the curb, regardless of land use. It is essential that applicants or those responsible for stormwater maintenance have the ability to impose parking regulations to facilitate proper sweeping, particularly in densely populated or heavily traveled areas, so that sweepers can get as close to curbs as possible.

A good street sweeping program requires an efficient sweeper. There are three types of sweepers: Mechanical, Regenerative Air, and Vacuum Filter. Each has a different ability to remove TSS.

- Mechanical: Mechanical sweepers use brooms or rotary brushes to scour the pavement. Although most of the sweepers currently in use in Massachusetts are mechanical sweepers, they are not effective at removing TSS (from 0% to 20% removal). Mechanical sweepers are especially ineffective at picking up fine particles (“fines”) (less than 100 microns).
- Regenerative Air: These sweepers blow air onto the road or parking lot surface, causing fines to rise where they are vacuumed. Regenerative air sweepers may blow fines off the vacuumed portion of the roadway or parking lot, where they contaminate stormwater when it rains.
- Vacuum filter: These sweepers remove fines along roads. Two general types of vacuum filter sweepers are available - wet and dry. The dry type uses a broom in combination with the vacuum. The wet type uses water for dust suppression. Research indicates vacuum sweepers are highly effective in removing TSS. The best ones (in terms of pollutant removal efficiencies) typically cost about $240,000 to $310,000.

Regardless of the type chosen, the efficiency of street sweeping is increased when sweepers are operated in tandem.

The frequency of sweeping is a major factor in determining efficiency. Unlike other stormwater treatment practices that function whenever it rains, street sweeping only picks up street dirt when streets and parking lots are actually swept. TSS removal efficiency is determined based on annual loading rates. If a road were swept only once a year with a sweeper that is 100% efficient, it would remove only a small fraction of the annual TSS load.

Street dirt accumulates on roads and parking lots and runs off in response to precipitation. The average interval between precipitation events in Massachusetts is approximately 3 days. Therefore, the hypothetical maximum effectiveness for street dirt removal requires sweeping at least once every 3 days, with a street sweeper with 100% efficiency at removing solids on paved surfaces before they become suspended. Modeling studies by Claytor (1999) in the Pacific Northwest suggest that optimum pollutant removal occurs when surfaces are swept every two weeks.

Because street sweeping may be an effective source reduction tool, a credit towards the 80% TSS removal standard *may* be available. ***At the discretion of the issuing authority****, a street sweeping program is eligible to receive credit towards the 80% TSS removal standard as set forth in the Table SS 1.*

TSS REMOVAL CREDITS FOR STREET SWEEPING

Table SS 1

TSS Removal Rate	High Efficiency Vacuum Sweeper – Frequency of Sweeping	Regenerative Air Sweeper – Frequency of Sweeping	Mechanical Sweeper (Rotary Broom)
10%	Monthly Average, with sweeping scheduled primarily in spring and fall.	Every 2 Weeks Average, with sweeping scheduled primarily in spring and fall.	Weekly Average, with sweeping scheduled primarily in spring and fall.
5%	Quarterly Average, with sweeping scheduled primarily in spring and fall.	Quarterly Average, with sweeping scheduled primarily in spring and fall.	Monthly Average, with sweeping scheduled primarily in spring and fall.
0%	Less than above	Less than above	Less than above

Street sweeping is not recommended as a practice to receive a TSS removal credit for post-construction period runoff, if the road or parking lot shoulders are not stabilized.

All TSS Removal Credits shown in Table SS 1 assume that the sweeping program gives special attention to sweeping paved surfaces in March/April before spring rains wash residual sand from winter applications into streams. If this assumption is not correct, the issuing authority should reduce the TSS removal credit by 50%.

Planning Considerations

In deciding whether street sweeping is an effective option, consider factors such as whether road and parking lot shoulders are stabilized, the speed at which the sweepers will need to be driven (safety factor such as along a highway), whether access is available to the curb (whether vehicles parked along the curb line will preclude sweeping of the curb line), the type of sweepers, and whether the sweepers will be operated in tandem. Municipalities or private developers that are planning to purchase a new street sweeper should consider vacuum sweepers, because they are most consistently effective.

Maintenance

Reuse and Disposal of Street Sweepings

Once removed from paved surfaces, the sweeping must be handled and disposed of properly. MassDEP's Bureau of Waste Prevention has issued a written policy regarding the reuse and disposal of street sweepings. These sweepings are regulated as a solid waste, and can be used in three ways:

- In one of the ways already approved by MassDEP (e.g., daily cover in a landfill, additive to compost, fill in a public way)
- If approved under a Beneficial Use Determination
- Disposed in a landfill

MassDEP provides guidance and standards for handling, reusing, and disposing of street sweepings. (For more information, go to: www.mass.gov/dep/recycle/laws/stsweep.htm)

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Deep Sump Catch Basin

Description: Deep sump catch basins, also known as oil and grease or hooded catch basins, are underground retention systems designed to remove trash, debris, and coarse sediment from stormwater runoff, and serve as temporary spill containment devices for floatables such as oils and greases.

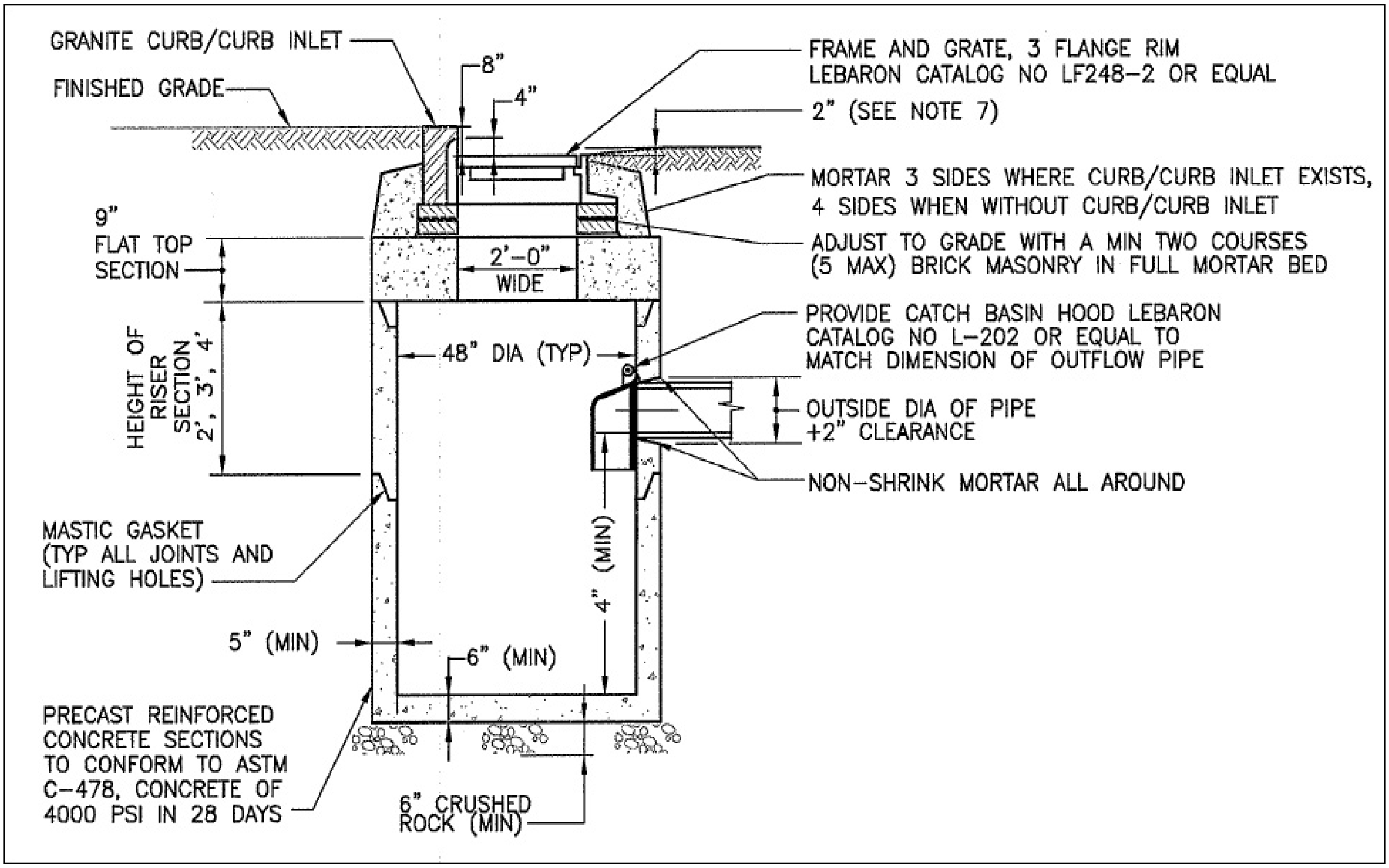
Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	25% TSS removal credit when used for pretreatment. Because of their limited effectiveness and storage capacity, deep sump catch basins receive credit for removing TSS only if they are used for pretreatment and designed as off-line systems.
5 - Higher Pollutant Loading	Recommended as pretreatment BMP. Although provides some spill control capability, a deep sump catch basin may not be used in place of an oil grit separator or sand filter for land uses that have the potential to generate runoff with high concentrations of oil and grease such as: high-intensity-use parking lots, gas stations, fleet storage areas, vehicle and/or equipment maintenance and service areas.
6 - Discharges near or to Critical Areas	May be used as pretreatment BMP. not an adequate spill control device for discharges near or to critical areas.
7 - Redevelopment	Highly suitable.

Advantages/Benefits:
- Located underground, so limited lot size is not a deterrent.
- Compatible with subsurface storm drain systems.
- Can be used for retrofitting small urban lots where larger BMPs are not feasible.
- Provide pretreatment of runoff before it is delivered to other BMPs.
- Easily accessed for maintenance.
- Longevity is high with proper maintenance.

Disadvantages/Limitations:
- Limited pollutant removal.
- Expensive to install and maintain, resulting in high cost per unit area treated.
- No ability to control volume of stormwater
- Frequent maintenance is essential
- Requires proper disposal of trapped sediment and oil and grease
- Entrapment hazard for amphibians and other small animals

Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) - 25% (for regulatory purposes)
- Nutrients (Nitrogen, phosphorus) - Insufficient data
- Metals (copper, lead, zinc, cadmium) - Insufficient data
- Pathogens (coliform, e coli) - Insufficient data



adapted from the University of New Hampshire

Maintenance

Activity	Frequency
Inspect units	Four times per year
Clean units	Four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

Special Features

All deep sump catch basins must include hoods. For MassHighway projects, consult the Stormwater Handbook for Highways and Bridges for hood requirements.

LID Alternative

Reduce Impervious Surface
Disconnect rooftop and non-rooftop runoff
Vegetated Filter Strip

Deep Sump Catch Basin

Suitable Applications

- Pretreatment
- Residential subdivisions
- Office
- Retail

Design Considerations

- The contributing drainage area to any deep sump catch basin should not exceed ¼ acre of impervious cover.
- Design and construct deep sump catch basins as off-line systems.
- Size the drainage area so that the flow rate does not exceed the capacity of the inlet grate.
- Divert excess flows to another BMP intended to meet the water quantity requirements (peak rate attenuation) or to a storm drain system. An off-line design enhances pollutant removal efficiency, because it prevents the resuspension of sediments in large storms.

Make the sump depth (distance from the bottom of the outlet pipe to the bottom of the basin) at least four feet times the diameter of the outlet pipe and more if the contributing drainage area has a high sediment load. The minimum sump depth is 4 feet. Double catch basins, those with 2 inlet grates, may require deeper sumps. Install the invert of the outlet pipe at least 4 feet from the bottom of the catch basin grate.

The inlet grate serves to prevent larger debris from entering the sump. To be effective, the grate must have a separation between the grates of one square inch or less. The inlet openings must not allow flows greater than 3 cfs to enter the deep sump catch basin. If the inlet grate is designed with a curb cut, the grate must reach the back of the curb cut to prevent bypassing. The inlet grate must be constructed of a durable material and fit tightly into the frame so it won't be dislodged by automobile traffic. The inlet grate must not be welded to the frame so that sediments may be easily removed. To facilitate maintenance, the inlet grate must be placed along the road shoulder or curb line rather than a traffic lane.

Note that within parking garages, the State Plumbing Code regulates inlet grates and other stormwater management controls. Inlet grates inside parking garages are currently required to have much smaller openings than those described herein.

To receive the 25% removal credit, hoods must be used in deep sump catch basins. Hoods also help contain oil spills. MassHighway may install catch basins without hoods provided they are designed, constructed, operated, and maintained in accordance with the Mass Highway Stormwater Handbook.

Install the weep hole above the outlet pipe. Never install the weep hole in the bottom of the catch basin barrel.

Site Constraints

A proponent may not be able to install a deep sump catch basin because of:

- Depth to bedrock;
- High groundwater;
- Presence of utilities; or
- Other site conditions that limit depth of excavation because of stability.

Maintenance

Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. One study found that once 50% of the sump volume is filled, the catch basin is not able to retain additional sediments.

Inspect or clean deep sump basins at least four times per year and at the end of the foliage and snow-removal seasons. Sediments must also be removed four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. If handling runoff from land uses with higher potential pollutant loads or discharging runoff near or to a critical area, more frequent cleaning may be necessary.

Clamshell buckets are typically used to remove sediment in Massachusetts. However, vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

Always consider the safety of the staff cleaning deep sump catch basins. Cleaning a deep sump catch basin within a road with active traffic or even within a parking lot is dangerous, and a police detail may be necessary to safeguard workers.

Although catch basin debris often contains concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal. Contaminated catch basin cleanings must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

In the absence of evidence of contamination, catch basin cleanings may be taken to a landfill or other facility permitted by MassDEP to accept solid waste, without any prior approval by MassDEP. However, some landfills require catch basin cleanings to be tested before they are accepted.

With prior MassDEP approval, catch basin cleanings may be used as grading and shaping materials at landfills undergoing closure (see Revised Guidelines for Determining Closure Activities at Inactive Unlined Landfill Sites) or as daily cover at active landfills. MassDEP also encourages the beneficial reuse of catch basin cleanings whenever possible. A Beneficial Reuse Determination is required for such use.

MassDEP regulations prohibit landfills from accepting materials that contain free-draining liquids. One way to remove liquids is to use a hydraulic lift truck during cleaning operations so that the material can be decanted at the site. After loading material from several catch basins into a truck, elevate the truck so that any free-draining liquid can flow back into the structure. If there is no free water in the truck, the material may be deemed to be sufficiently dry. Otherwise the catch basin cleanings must undergo a Paint Filter Liquids Test. Go to www. Mass.gov/dep/recycle/laws/cafacts.doc for information on all of the MassDEP requirements pertaining to the disposal of catch basin cleanings.

Oil/Grit Separators

Description: Oil/grit separators are underground storage tanks with three chambers designed to remove heavy particulates, floating debris and hydrocarbons from stormwater.

Stormwater enters the first chamber where heavy sediments and solids drop out. The flow moves into the second chamber where oils and greases are removed and further settling of suspended solids takes place. Oil and grease are stored in this second chamber for future removal. After moving into the third outlet chamber, the clarified stormwater runoff is then discharged to a pipe and another BMP. There are other separators that may be used for spill control.

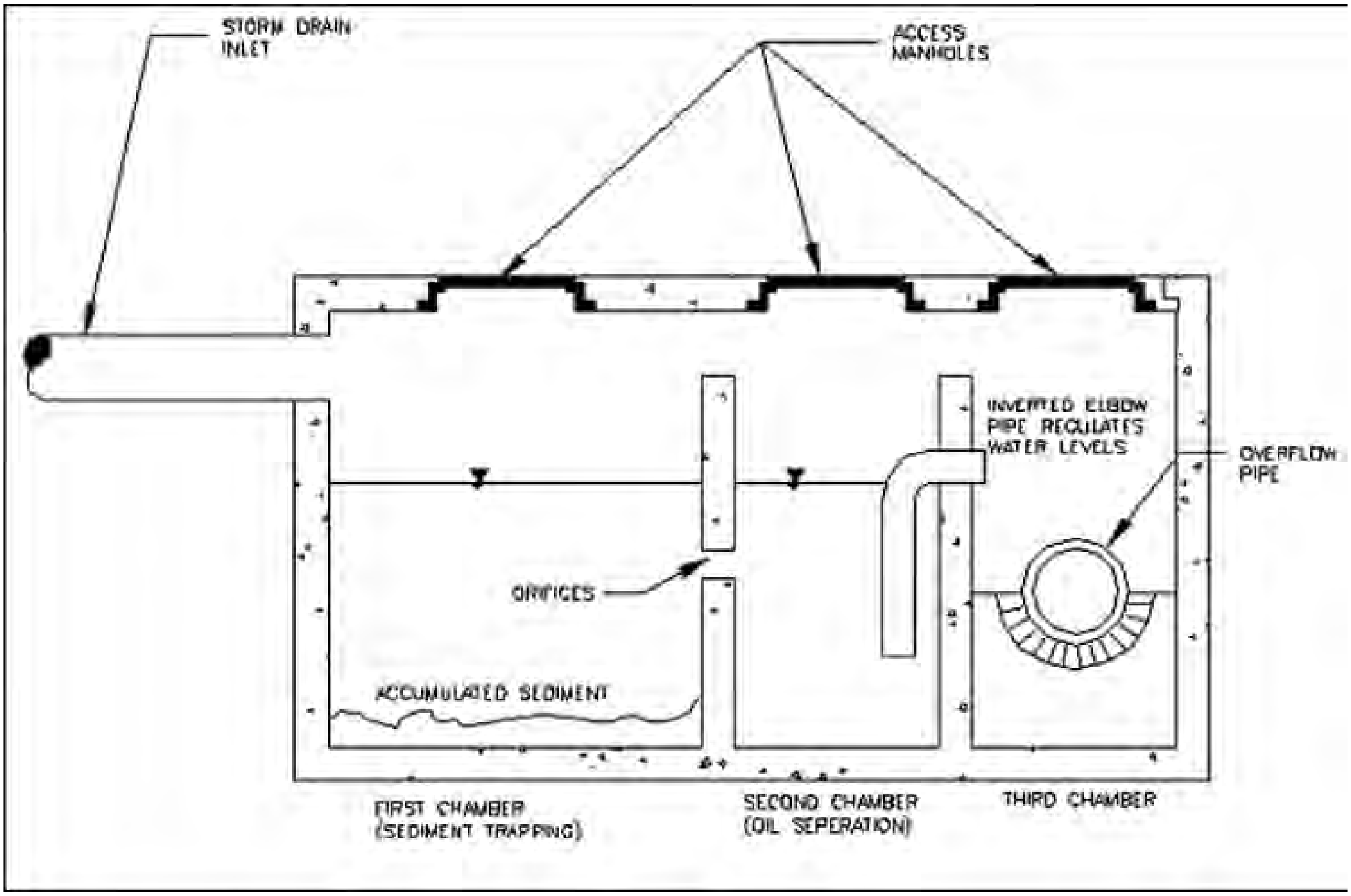
Advantages/Benefits:
- Located underground so limited lot size not a deterrent in urban areas with small lots
- Can be used for retrofits
- Can be installed in any soil or terrain.
- Public safety risks are low.

Disadvantages/Limitations:
- Limited pollutant removal; cannot effectively remove soluble pollutants, fine particles, or bacteria
- Can become a source of pollutants due to resuspension of sediment unless properly maintained
- Susceptible to flushing during large storms
- Limited to relatively small contributing drainage areas
- Requires proper disposal of trapped sediments and oils
- May be expensive to construct and maintain
- Entrapment hazard for amphibians and other small animals

Pollutant Removal Efficiencies
- Total Suspended Solids (TSS) - 25% for oil grit separator, only when placed off-line and only when used for pretreatment
- Nutrients (Nitrogen, phosphorus) - Insufficient data
- Metals (copper, lead, zinc, cadmium) - Insufficient data
- Pathogens (coliform, e coli) - Insufficient data

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	25% TSS removal credit when used for pretreatment and placed off-line.
5 - Higher Pollutant Loading	MassDEP requires a pretreatment BMP, such as an oil/grit separator that is capable of removing oil and grease, for land uses with higher potential pollutant loads where there is a risk of petroleum spills such as: high intensity use parking lots, gas stations, fleet storage areas, vehicle and/or equipment maintenance and service areas.
6 - Discharges near or to Critical Areas	May be a pretreatment BMP when combined with other practices. May serve as a spill control device.
7 - Redevelopment	Highly suitable.



MassHighway 2004

Maintenance

Activity	Frequency
Inspect units	After every major storm but at least monthly
Clean units	Twice a year

Oil/Grit Separators

Applicability

Oil grit separators must be used to manage runoff from land uses with higher potential pollutant loads where there is a risk that the stormwater is contaminated with oil or grease. These uses include the following:

- High-Intensity-Use Parking Lots
- Gas Fueling Stations
- Vehicles (including boats, buses, cars, and trucks) and Equipment Service and Maintenance Areas
- Fleet Storage Areas

Design Considerations

- Dovetail design practices, source controls and pollution prevention measures with separator design.
- Place separators before all other structural stormwater treatment practices (except for structures associated with source control/ pollution prevention such as drip pans and structural treatment practices such as deep sump catch basins that double as inlets).
- Limit the contributing drainage area to the oil/grit separator to one acre or less of impervious cover.
- Use oil grit separators only in off-line configurations to treat the required water quality volume.
- Provide pool storage in the first chamber to accommodate the required water quality volume or 400 cubic feet per acre of impervious surface. Confirm that the oil/grit separator is designed to treat the required water quality volume.
- Make the permanent pool at least 4 feet deep.
- Design the device to pass the 2-year 24-hour storm without interference and provide a bypass for larger storms to prevent resuspension of solids.
- Make oil/grit separator units watertight to prevent possible groundwater contamination.
- Use a trash rack or screen to cover the discharge outlet and orifices between chambers.
- Provide each chamber with manholes and access stepladders to facilitate maintenance and allow cleaning without confined space entry.
- Seal potential mosquito entry points.
- Install any pump mechanism downstream of the separator to prevent oil emulsification.
- Locate an inverted elbow pipe between the second and third chambers and with the bottom of the elbow pipe at least 3 feet below the second chamber's permanent pool.
- Provide appropriate removal covers that allow access for observation and maintenance.
- Where the structure is located below the seasonal high groundwater table, design the structure to prevent flotation.
- For gas stations, automobile maintenance and service areas, and other areas where large volumes of petroleum and oil are handled, consider adding coalescing plates to increase the effectiveness of the device and reduce the size of the units. A series of coalescing plates constructed of oil-attracting materials such as polypropylene typically spaced one inch apart attracts small droplets of oil, which begin to concentrate until they are large enough to float to the surface.

Maintenance

Sediments and associated pollutants and trash are removed only when inlets or sumps are cleaned out, so regular maintenance is essential. Most studies have linked the failure of oil grit separators to the lack of regular maintenance. The more frequent the cleaning, the less likely sediments will be resuspended and subsequently discharged. In addition, frequent cleaning also makes more volume available for future storms and enhances overall performance. Cleaning includes removal of accumulated oil and grease and sediment using a vacuum truck or other ordinary catch basin cleaning device. In areas of high sediment loading, inspect and clean inlets after every major storm. At a minimum, inspect oil grit separators monthly, and clean them out at least twice per year. Polluted water or sediments removed from an oil grit separator should be disposed of in accordance with all applicable local, state and federal laws and regulations including M.G.L.c. 21C and 310 CMR 30.00.

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Subsurface Structures

Description: Subsurface structures are underground systems that capture runoff, and gradually infiltrate it into the groundwater through rock and gravel. There are a number of underground infiltration systems that can be installed to enhance groundwater recharge. The most common types include pre-cast concrete or plastic pits, chambers (manufactured pipes), perforated pipes, and galleys.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	Provides groundwater recharge
4 - TSS Removal	80%
5 - Higher Pollutant Loading	May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. Land uses with the potential to generate runoff with high concentrations of oil and grease require an oil grit separator or equivalent prior to discharge to the infiltration structure. Infiltration must be done in accordance with 314 CMR 5.00.
6 - Discharges near or to Critical Areas	Highly recommended
7 - Redevelopment	Suitable with pretreatment

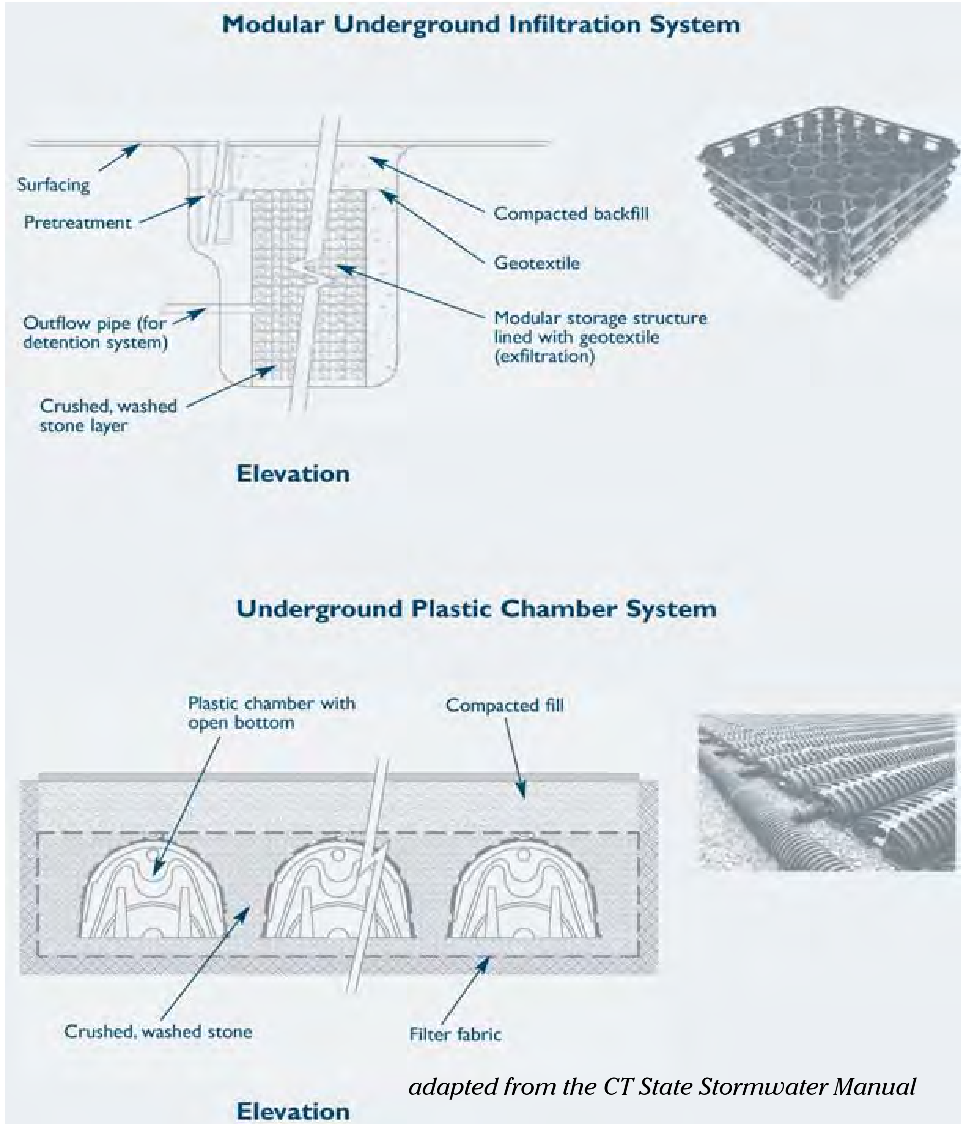
Advantages/Benefits:
- Provides groundwater recharge
- Reduces downstream flooding
- Preserves the natural water balance of the site
- Can remove other pollutants besides TSS
- Can be installed on properties with limited space
- Useful in stormwater retrofit applications

Disadvantages/Limitations:
- Limited data on field performance
- Susceptible to clogging by sediment
- Potential for mosquito breeding due to standing water if system fails

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	80%
• Nutrients (Nitrogen, phosphorus)	Insufficient data
• Metals (copper, lead, zinc, cadmium)	Insufficient data
• Pathogens (coliform, e coli)	Insufficient data

Subsurface Structures



adapted from the CT State Stormwater Manual

There are different types of subsurface structures:

Infiltration Pit: A pre-cast concrete or plastic barrel with uniform perforations. The bottom of the pit should be closed with the lowest row of perforations at least 6 inches above the bottom, to serve as a sump. Infiltration pits typically include an observation well. The pits may be placed linearly, so that as the infiltrative surfaces in the first pit clog, the overflow moves to the second pit for exfiltration. Place an outlet near the top of the infiltration pit to accommodate emergency overflows. MassDEP provides recharge credit for storage below the emergency outflow invert. To make an infiltration pit, excavate the pit, wrap fabric around the barrel, place stone in the bottom of the pit, place the barrel in the pit, and then backfill stone around the barrel. Take a boring or dig an observation trench at the site of each proposed pit.

Chambers: These are typically manufactured pipes containing open bottoms and sometimes perforations. The chambers are placed atop a stone bed. Take the same number of borings or observation pits as for infiltration trenches. Do not confuse these systems with underground detention systems (UDS) that use similar chambers. UDS are designed to attenuate peak rates of runoff--not to recharge groundwater.

Perforated Pipes: In this system, pipes containing perforations are placed in a leaching bed, similar to a Title 5 soil absorption system (SAS). The pipes dose the leaching bed. Take the same number of borings or observation pits as for infiltration trenches. Perforated pipes by themselves do not constitute a stormwater recharge system and receive no credit pursuant to Stormwater Standard No. 3. Do not confuse recharge systems that use perforated pipes with perforated pipes installed to lower the water table or divert groundwater flows.

Galleys: Similar to infiltration pits. Some designs consist of concrete perforated rectangular vaults. Others are modular systems usually placed under parking lots. When the galley design consists of a single rectangular perforated vault, conduct one boring or observation trench per galley. When the galleys consist of interlocking modular units, take the same number of borings or observation pits as for infiltration trenches. Do not confuse these galleys with vaults storing water for purposes of underground detention, which do not contain perforations.

Applicability

Subsurface structures are constructed to store stormwater temporarily and let it percolate into the underlying soil. These structures are used for small drainage areas (typically less than 2 acres). They are feasible only where the soil is adequately permeable and the maximum water table and/or bedrock elevation is sufficiently low. They can be used to control the quantity as well as quality of stormwater runoff, if properly designed and constructed. The structures serve as storage chambers for captured stormwater, while the soil matrix provides treatment.

Without adequate pretreatment, subsurface structures are not suitable for stormwater runoff from land uses or activities with the potential for high sediment or pollutant loads. Structural pretreatment BMPs for these systems include, but are not limited to, deep sump catch basins, proprietary separators, and oil/grit separators. They are suitable alternatives to traditional infiltration trenches and basins for space-limited sites. These systems can be installed beneath parking lots and other developed areas provided the systems can be accessed for routine maintenance.

Subsurface systems are highly prone to clogging. Pretreatment is always required unless the runoff is strictly from residential rooftops.

Effectiveness

Performance of subsurface systems varies by manufacturer and system design. Although there are limited field performance data, pollutant removal efficiency is expected to be similar to those of infiltration trenches and basins (i.e., up to 80% of TSS removal). MassDEP awards a TSS removal credit of 80% for systems designed in accordance with the specifications in this handbook.

Planning Considerations

Subsurface structures are excellent groundwater recharge alternatives where space is limited. Because infiltration systems discharge runoff to groundwater, they are inappropriate for use in areas with potentially higher pollutant loads (such as gas stations), unless adequate pretreatment is provided. In that event, oil grit separators, sand filters or equivalent BMPs must be used to remove sediment, floatables and grease prior to discharge to the subsurface structure.

Design

Unlike infiltration basins, widely accepted design standards and procedures for designing subsurface structures are not available. Generally, a subsurface structure is designed to store a "capture volume" of runoff for a specified period of "storage time." The definition of capture volume differs depending on the purpose of the subsurface structure and the stormwater management program being used. Subsurface structures should infiltrate good quality runoff only. Pretreatment prior to infiltration is essential.
The composition, configuration and layout of subsurface structures varies considerably depending on the manufacturer. Follow the design criteria specified by vendors or system manufacturers. Install subsurface structures in areas that are easily accessible for routine and non-routine maintenance.

As with infiltration trenches and basins, install subsurface structures only in soils having suitable infiltration capacities as determined through field testing. Determine the infiltrative capacity of the underlying native soil through the soil evaluation set forth in Volume 3. Never use a standard septic system percolation test to determine soil permeability because this test tends to greatly overestimate the infiltration capacity of soils.

Subsurface structures are typically designed to function off-line. Place a flow bypass structure upgradient of the infiltration structure to convey high flows around the structure during large storms.

Design the subsurface structure so that it drains within 72 hours after the storm event and completely dewaters between storms. Use a minimum draining time of 6 hours to ensure adequate pollutant removal. Design all ports to be mosquito-proof, i.e., to inhibit or reduce the number of mosquitoes able to breed within the BMP.

The minimum acceptable field infiltration rate is 0.17 inches per hour. Subsurface structures must be sized in accordance with the procedures set forth in Volume 3. Manufactured structures must also be sized in accordance with the manufacturers' specifications. Design the system to totally exfiltrate within 72 hours.

Design the subsurface structure for live and dead loads appropriate for their location. Provide measures to dissipate inlet flow velocities and prevent channeling of the stone media. Generally, design the system so that inflow velocities are less than 2 feet per second (fps).
All of these devices must have an appropriate number of observation wells, to monitor the water surface elevation within the well, and to serve as a sampling port.

Each of these different types of structures, with the exception of perforated pipes in leaching fields similar to Title 5 systems, must have entry ports to allow worker access for maintenance, in accordance with OSHA requirements.

Construction

Stabilize the site prior to installing the subsurface structure. Do not allow runoff from any disturbed areas on the site to flow to the structure. Rope off the area where the subsurface structures are to be placed. Accomplish any required excavation with equipment placed just outside of this area. If the size of the area intended for exfiltration is too large to accommodate this approach, use trucks with low-pressure tires to minimize compaction. Do not allow any other vehicles within the area to be excavated. Keep the area above and immediately surrounding the subsurface structure roped off to all construction vehicles until the final top surface is installed (either paving or landscaping). This prevents additional compaction. When installing the final top surface, work from the edges to minimize compaction of the underlying soils.

Before installing the top surface, implement erosion and sediment controls to prevent sheet flow or wind blown sediment from entering the leach field. This includes, but is not limited to, minimizing land disturbances at any one time, placing stockpiles away from the area intended for infiltration, stabilizing any stockpiles through use of vegetation or tarps, and placing sediment fences around the perimeter of the infiltration field.

Provide an access port, man-way, and observation well to enable inspection of water levels within the system. Make the observation well pipe visible at grade (i.e., not buried).

Maintenance

Because subsurface structures are installed underground, they are extremely difficult to maintain. Inspect inlets at least twice a year. Remove any debris that might clog the system. Include mosquito controls in the Operation and Maintenance Plan.

Adapted from:
Connecticut Department of Environmental Conservation. Connecticut Stormwater Quality Manual. 2004.
MassHighway. Storm Water Handbook for Highways and Bridges. May 2004.

III. APPENDIX F

Stormwater Pollution Prevention Plan (SWPPP)

(will be finalized and submitted before construction commences)

III. APPENDIX G

Operation and Maintenance Plan (O&M)
with
Long Term Pollution Prevention Plan (LTPPP)

Operation and Maintenance Plan

The Arsenal Project
Arsenal Street
Watertown, MA 02472

Prepared for:

Boylston Properties
800 Boylston Street, Suite 1390
Boston, MA 02199

and

The Wilder Companies
800 Boylston Street, Suite 1300
Boston, MA 02199

Prepared by:

RJ O'CONNELL & ASSOCIATES, INC.
80 Montvale Ave, Suite 201
Stoneham, MA 02180

Date:

July 11, 2016

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Operations and Maintenance Plan

INTRODUCTION

This Operations and Maintenance Plan has been prepared to ensure that the stormwater management system implemented for The Arsenal Project to functions as designed and to develop and carry out suitable practices for source control and pollution prevention. It consists of six sections:

Section 1 - Stormwater Management System-Operations and Maintenance, which describes the various components of the stormwater management system, identifies the inspection and maintenance tasks to be undertaken after construction is complete and a schedule for implementing these tasks to insure the proper, long-term operation of the system.

Section 2 - Long Term Pollution Prevention Plan which identifies and implements suitable measures, practices and procedures for source control and pollution prevention.

Section 3- Illicit Discharge Statement.

Section 4- Snow Management and Disposal Plan which describes how snow removal will be managed and deicing operations performed.

Section 5- Public Safety Features which lists features of the stormwater management system to insure the safety of the public.

SECTION 1 – STORMWATER MANAGEMENT SYSTEM- OPERATION AND MAINTENANCE

The objectives of the stormwater management system are to effectively control and treat stormwater runoff from the site in accordance with the Massachusetts Stormwater Management Standards. To accomplish this objective, the following Best Management Practices (BMP's) are included in the proposed office building's stormwater management system:

<u>Pre-treatment BMP's</u>

- Sweeping of paved surface areas to remove solids and reduce suspended solids in surface runoff.
- Maintaining catch basins to reduce the discharge of sediment and pollutants.
- Maintaining oil/particle separators for removal of Total Suspended Solids (TSS), oil and grease.

<u>Treatment BMP's</u>

- Maintaining the subsurface infiltration systems to recharge groundwater, reduce peak rates of runoff from the site and remove suspended solids from stormwater runoff through infiltration into the ground.

To ensure the ongoing and proper functioning of the on-site stormwater management/BMP facilities, this Operations and Maintenance Plan has been developed.

In consideration of the foregoing, it is the ongoing responsibility of the Landowner, his successors and assignees to adequately maintain the on-site stormwater management/BMP facilities. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions.

Based on this, the Landowner, his successors and assignees are required to create a Pollution Prevention Team (PPT) that will be responsible for implementing the Operations and Maintenance Plan.
Upon transfer of ownership of the property, the Landowner is required to notify the new owner of the presence of the stormwater management system and the requirements of this Operations and Maintenance Plan.

<u>Property Information</u>

Address: 485 Arsenal Street
Watertown, MA 02472

Landowner and Pollution Prevention Team Leader

Owner's Name: Boylston Properties and The Wilder Companies
Team Leader: TBD
Title: Owner
Office Phone: TBD
Email: TBD

Responsibilities: Coordinate all aspects of the Operations and Maintenance Plan, coordinate and hire the other Pollution Prevention team members in order to conduct inspections, keep all records, coordinate with contractors for maintenance and repairs of the stormwater management system.

Spill Prevention & Control Contractor
The following contacts shall be notified only in those instances identified within MA DEP-310 CMR 40-subpart C.

Primary Contact: TBD
Office Phone: TBD

Emergency Contact:
Company Name: TBD
Contact Name: TBD
Emergency Phone: TBD

Consultant Contact:
Company Name: TBD
Contact Name: TBD
Phone: TBD

Department of Environmental Protection (DEP) Contact
Spill Emergency Coordinator
Contact Name: TBD
Phone: TBD

Municipal Contacts
Contact Name: Town of Watertown, Department of Public Works, Gerald S. Mee, Jr., Superintendent
Phone: 781-972-6420

Other Pollution Prevention Team Members

Member: Qualified Engineering and/or Environmental Consulting Firm(s)
Responsibilities: Conduct scheduled inspections, maintain records, advise the Team Leader of maintenance needs, ensure inspection maintenance and repairs are completed, keep and maintain all records and inspection reports.

Company Name(s): TBD
Address:
Office Phone:

Team Member Training

The Pollution Prevention Team Leader will coordinate an annual in-house training session with the qualified Engineering and/or Environmental Consulting Firm to discuss the Operations and Maintenance Plan, ongoing inspection and maintenance and preventative maintenance procedures.

Annual training session will generally include the following:

- Discuss the Operations and Maintenance Plan
    - What it is- identify potential sources of stormwater pollution and methods of reducing or eliminating that pollution
    - What it contains- emphasize good housekeeping measures and location of potential pollution sources.
    - Pollution Prevention Team- introduce the team and responsibilities, explain that the objective is to continually monitor the stormwater management system and encourage input and assistance from all.
- Review and explain the storm drainage system, how it works and its components, note the receiving resource area in which the storm drainage system discharges into and the role each one of these areas play.
- Emphasize the importance of maintaining current and up-to-date inspection reports and maintenance records of BMP's. Documentation shall include any changes to the O&M Plan's procedures to accommodate changes and revisions to BMP's.

The components of the stormwater management system must be inspected, monitored and maintained in accordance with the following in order to ensure that the on-site stormwater management/BMP facilities for The Arsenal Project are functioning as designed. Routine inspection and proper maintenance of these individual components is essential to providing the long-term enhancement of both the quality and quantity of the runoff from the property.

Catch Basins:

Stormwater runoff from pavement areas is directed to catch basins via curbing and site grading. To ensure proper functioning of catch basins, each on-site catch basin will be inspected and maintained as follows:

> Inspection: Quarterly and after major storm events (3.2 inches or more in a 24 hour period). Structural damage and other malfunctions to be noted and reported.

Maintenance: Cleaned four times a year or when the sump is half full by a licensed contractor. Sediment and hydrocarbons will be properly handled and legally disposed of off site in accordance with local, state, and federal guidelines and regulations. Any structural damage to catch basins and/or castings will be repaired upon discovery.

Sweeping and Site Clean-Up

Routine sweeping of paved areas is an effective method to provide important nonpoint source pollution control and will be performed by mechanical sweepers. Most stormwater pollutants travel with the suspended solids contained in the stormwater runoff and regular sweeping will help reduce a portion of this load. Sweeping, especially during the period immediately following winter snowmelt (March/April) when road sand and other debris has accumulated on the pavement, will capture a peak sediment load before spring rains wash residual sand from winter applications into nearby resource areas.

Inspection: Paved areas will be inspected for litter on a weekly basis and picked up and disposed of immediately.

Maintenance: All parking areas, sidewalks, driveways and other impervious surfaces (except roofs) will be swept clean of sand, litter, trash, etc. on a monthly basis. A log of land/lot sweeping and cleanup will be kept. Housekeeping concerns noted by store leadership, PPT members, guests and others will be noted and acted upon. Separate cleanup services will be conducted at least twice a year, once between November 14 and December 15 (after leaf fall) and once during the month of April (after snow melt). Additional cleanup services will be conducted as necessary.

CDS Oil/Particle Separators

The Continuous Deflective Separator (CDS) unit separates and traps debris, sediment and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material. There are seven CDS units on site designed to treat stormwater runoff prior to discharging into the subsurface infiltration systems.

Inspection: Quarterly

Maintenance: Jet/vacuumed by a licensed contractor at least twice per year. Accumulated sediment and hydrocarbons will be disposed of in accordance with applicable local, state and federal guidelines and regulations.

Subsurface Infiltration Systems

Subsurface infiltration systems are located along the south side of the site, adjacent to Greenough Boulevard and beneath the parking lot next to Building E1. The systems consist of either 5 or 10 ft. diameter, perforated, corrugated metal pipes surrounded in crushed stone. The systems are designed to temporarily retain storm runoff and infiltrate it into the underlying soil.

> Inspection: Inlets to be inspected twice a year.
>
> Maintenance: Clean when there is a build-up of visible sediment at the inlet. Sediment to be removed by jet vacuum and disposed of legally in accordance with local, state and federal guidelines and regulations.

Please refer to Appendix A for the Inspection Forms, which are to be used by the Pollution Prevention Team member responsible for conducting the scheduled inspections.

SECTION 2 – LONG TERM POLLUTION PREVENTION PLAN (LTPPP)

A. MATERIALS COVERED

The following materials or substances are expected to be present onsite after construction:

Cleaning solvents	Petroleum based products
Detergents	Pesticides/Insecticides
Paints/Solvents	Fertilizers/Herbicides
Acids	Pet waste
Solid Waste	Contaminated Soil

B. MATERIALS MANAGEMENT PRACTICES

The following are the material management practices that will be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff. The Pollution Prevention Team Leader will be responsible for ensuring that these procedures are followed:

1. Good Housekeeping

   The following good housekeeping practices will be followed onsite after construction:

   a) An effort will be made to store only enough products required to do the job.
   b) All materials stored onsite will be stored in a neat, orderly manner and, if possible, under a roof or in a containment area. At a minimum, all containers will be stored with their lids on when not in use. Drip pans shall be provided under all dispensers.
   c) Products will be kept in their original containers with the original manufacturer's label in legible condition.
   d) Substances will not be mixed with one another unless recommended by the manufacturer.
   e) Whenever possible, all of a product will be used up before disposing of the container.
   f) Manufacturer's recommendations for proper use and disposal will be followed.
   g) A Pollution Prevention Team Member will be responsible for daily inspections to ensure proper use and disposal of materials.

2. Hazardous Substances

   These practices will be used to reduce the risks associated with Hazardous Substances. Material Safety Data Sheets (MSDS's) for each product with hazardous properties that is used at the Project will be obtained and used for the proper management of potential wastes that may result from these products. An MSDS will be posted in the immediate area where such product is stored and/or used and another copy of each MSDS will be maintained on-site, in the management office. Each employee who must handle a Hazardous Substance will be instructed on the use of MSDS sheets and the specific information in the applicable MSDS for the product he/she is using, particularly regarding spill control techniques.

a) Products will be kept in original containers with the original labels in legible condition.
b) Original labels and MSDS's will be procured and used for each product.
c) If surplus product must be disposed of, the manufacturer's and local/state/federal required methods for proper disposal must be followed.

3. Hazardous Waste

It is imperative that all Hazardous Waste be properly identified and handled in accordance with all applicable Hazardous Waste Standards, including the storage, transport and disposal of the Hazardous Wastes. There are significant penalties for the improper handling of Hazardous Wastes. It is important that the Pollution Prevention Team Leader seeks appropriate assistance in making the determination of whether a substance or material is a Hazardous Waste. For example, Hazardous Waste may include certain Hazardous Substances, as well as pesticides, paints, paint solvents, cleaning solvents, contaminated soils, and other materials, substances or chemicals that have been discarded (or are to be discarded) as being out-of-date, contaminated, or otherwise unusable. The Pollution Prevention Team Leader is responsible for ensuring that all Pollution Prevention Team Members are instructed as to these Hazardous Waste requirements and also that the requirements for handling and disposal are being followed.

4. Product Specific Practices

The following product specific practices will be followed on the job site:

a) Petroleum Products

Petroleum products will be stored in tightly sealed containers which are clearly labeled. Petroleum storage tanks shall be located a minimum of 100 linear feet from wetland resource areas, drainage ways, inlets and surface waters unless stored within a building. Any petroleum storage tanks stored onsite will be located within a containment area that is designed with an impervious surface between the tank and the ground. The secondary containment must be designed to provide a containment volume that is equal to 110% of the volume of the largest tank. Drip pans shall be provided for all dispensers. Any asphalt substances used onsite will be applied according to the manufacturer's recommendations. The location of any fuel tanks and/or equipment storage areas must be identified on the Erosion Control Plan by the Contractor once the locations have been determined.

b) Fertilizers, Herbicides, Pesticides, and Insecticides

Fertilizers, herbicides, pesticides, insecticides and/or pool chemicals will be applied only in the minimum amounts recommended by the manufacturer. Once applied, they will be worked so as to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags or containers will be transferred to a sealable plastic bin to avoid spills.

c) Paints, Paint Solvents, and Cleaning Solvents

All containers will be tightly sealed and stored when not in use. Excess paint and solvents will not be discharged to the storm sewer system but will be properly disposed of according to manufacturer's instructions or state and federal regulations.

5. Solid Waste

All waste materials will be collected and stored in an appropriately covered container and/or securely contained metal dumpster rented from a local waste management company which must be a licensed solid waste management company. The dumpster will comply with all local and state solid waste management regulations.

All trash and debris from the site will be deposited in dumpsters. The dumpsters will be emptied a minimum of once per week or more often if necessary. All personnel will be instructed regarding the correct procedures for waste disposal.

All waste dumpsters and roll-off containers will be located in an area where the likelihood of the containers contributing to storm water discharges is negligible. No debris, refuse or other materials, including but not limited to landscaping debris, leaves, shrubs and tree trimmings, logs, bricks stone or trash shall be deposited within the vegetated wetland or within 100 feet of the vegetated wetland.

6. Contaminated Soils

Any contaminated soils (resulting from spills of Hazardous Substances or Oil) will be contained and cleaned up immediately in accordance with the procedures given in the Materials Management Plan and in accordance with applicable state and federal regulations. If there is a release, it should be reported as a spill, if it otherwise meets the requirements for a reportable spill.

7. Pet Waste

The site will be inspected weekly for pet waste. Pet waste will be collected, placed in a closed, tied trash bag and disposed of in accordance with applicable code requirements.

C. SPILL PREVENTION AND RESPONSE PROCEDURES

The Pollution Prevention Team Leader will train all personnel in the proper handling and cleanup of spilled Hazardous Substances or Oil. No spilled Hazardous Substances or Oil will be allowed to come in contact with storm water discharges. If such contact occurs, the storm water discharge will be contained on site until appropriate measures in compliance with state and federal regulations are taken to dispose of such contaminated storm water. It shall be the responsibility of the Pollution Prevention Team Leader to be properly trained, and to train all personnel in spill prevention and clean up procedures.

1. In order to prevent or minimize the potential for a spill of Hazardous Substances or Oil to come into contact with storm water, the following steps will be implemented:

   a) All Hazardous Substances or Oil (such as pesticides, petroleum products, fertilizers, detergents, acids, paints, paint solvents, cleaning solvents, etc.) will be stored in a secure location, with their lids on, preferably under cover, when not in use.
   b) The minimum practical quantity of all such materials will be kept on site.
   c) A spill control and containment kit (containing, for example, absorbent materials, acid neutralizing powder, brooms, dust pans, mops, rags, gloves, goggles, plastic and metal trash containers, etc.) will be provided on site.
   d) Manufacturer's recommended methods for spill cleanup will be clearly posted and site personnel will be trained regarding these procedures and the location of the information and cleanup supplies.
   e) It is the Pollution Prevention Team Leader's responsibility to ensure that all Hazardous Waste on site is disposed of properly by a licensed hazardous material disposal company. The Pollution Prevention Team Leader is responsible for not exceeding Hazardous Waste storage requirements mandated by the EPA or state and local authority.

2. In the event of a spill of Hazardous Substances or Oil, the following procedures must be followed:

   a) All measures must be taken to contain and abate the spill and to prevent the discharge of the Hazardous Substance or Oil to storm water or off-site. (The spill area must be kept well ventilated and personnel must wear appropriate protective clothing to prevent injury from contact with the Hazardous Substances.)

b) For spills of less than five (5) gallons of material, proceed with source control and containment, clean-up with absorbent materials or other applicable means unless an imminent hazard or other circumstances dictate that the spill should be treated by a professional emergency response contractor.

c) For spills greater than five (5) gallons of material immediately contact the MA DEP Hazardous Waste Incident Response Group at (617) 792-7653 and an approved emergency response contractor. Provide information on the type of material spilled, the location of the spill, the quantity spilled, and the time of the spill to the emergency response contractor or coordinator, and proceed with prevention, containment and/or clean-up if so desired.

d) If there is a Reportable Quantity (RQ) release, then the National Response Center will be notified immediately at (800) 424-8802; within 14 days a report will be submitted to the EPA regional office describing the release, the date and circumstances of the release and the steps taken to prevent another release. This Pollution Prevention Plan must be updated to reflect any such steps or actions taken and measures to prevent the same from reoccurring.

3. The Pollution Prevention Team Leader will be the spill prevention and response coordinator. He/she will designate the individuals who will receive spill prevention and response training. These individuals will each become responsible for a particular phase of prevention and response. The names of these personnel will be posted in the material storage area and in the management office.

SECTION 3 - ILLICIT DISCHARGE STATEMENT

Certain types of discharges are allowable under the U.S. Environmental Protection Agency Construction General Permit, and it is the intent of this LTPPP to allow such discharges. These types of discharges will be allowed under the conditions that no pollutants will be allowed to come in contact with the water prior to or after its discharge. The control measures which have been outlined previously in this LTPPP will be strictly followed to ensure that no contamination of these non-storm water discharges takes place. Illicit discharges, if they exist currently, will be contained and eliminated in the manner specified by local, state and federal regulations, and will be prohibited in the proposed development.

____

Jeff Heidelberg for Boylston Properties

SECTION 4 - SNOW MANAGEMENT AND DISPOSAL PLAN

Snow management will be overseen by a full-time Property Manager who will implement this plan and be authorized to utilize additional resources should unusual events occur. The Snow Management Contractor (SMC) shall be responsible for maintaining all roads, driveways, parking lots, sidewalks and pedestrian access areas for clear and safe travel. The SMC shall report directly to the Property Manager and maintain communication via cell phones 24 hours per day, 7 days per week. All roads, drives, entrances and exits are the first priority. During extreme events, the first priority will be to clear and maintain proper access for residents and public safety vehicles. The next priority is parking areas, sidewalks, fire hydrants, and delivery areas. Snow will not be piled around light bases and handicap parking areas shall be cleared frequently.

The anti-icing operations typically precede snow plowing and will be provided when conditions warrant. Within 12 months of concrete walks, pads, or other features being poured, no salt shall be placed on those surfaces. After the materials have cured for 12 months, a combination of salt (Halite or Rock Salt) and sand ("washed", fine to medium grade) shall be utilized. Parking areas shall receive spot treatment only when and where needed in a similar manner.

Snow plowing shall commence upon accumulation of two inches ("2") or more. Snow shall be deposited in designated areas. The SMC shall keep existing catch basins open for drainage or water resulting from melting.

Once the storm is over, the SMC shall monitor all areas on-site for icy spots and snowdrifts. If needed, an application of sand and salt will be applied to all streets and roads so that the riding surface remains drivable. When the ambient temperature drops below 25 degrees F, all major areas will receive an application of pre-wetted salt with calcium chloride to maintain melting action and an ice-free surface for as long as possible. Salt loses its effectiveness at temperatures drop below 25 degrees F.

Deicing chemicals will be kept in original containers with the original product label in legible condition. When not in use, deicing materials will be stored in a neat, orderly manner under cover with their container lids on.

SECTION 5 - PUBLIC SAFETY FEATURES

The following measures have been incorporated into the stormwater management system to insure the safety of the public:

- Storm drain manholes and catch basins provided with heavy duty covers and/or grates and designed to withstand H20 loading.

- Control and collection of stormwater runoff through positive drainage and curbing directing it toward drainage inlet structures.

- Treatment of stormwater runoff from paved surfaces to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

- Reduction in peak rates of runoff and volume from the site under post-redevelopment conditions as compared to pre-developed conditions.

- Development and implementation of an Operations and Maintenance Plan to insure the proper functioning of the stormwater management system and a Long Term Pollution Prevention Plan identifying potential pollution sources and suitable practices to control and prevent them from impacting the environment and/or the public's health and safety.

Appendix A
The Arsenal Project
Maintenance and Inspection Forms

The Arsenal Project
Operation and Maintenance Plan
Activity Guide

The table below is a list of the minimum inspection and maintenance activities the Pollution Prevention Team needs to conduct for the Stormwater Operations and Management Plan and who is responsible for the activity. The Activity Guide is provided to assist the Pollution Prevention Team Leader and ensure that the activities are being conducted as scheduled.

Timing	Activity	Responsible Party
Weekly	Inspect lot/land Pet waste management Parking lot sweeping	PPT PPT PPT Contractor
Quarterly	Inspect and clean catch basins Inspect CDS oil/ particle separators	PPT/Contractor PPT/Contractor
Semi-Annually	Clean CDS Oil/Particle Separators Inspect subsurface infiltration systems	PPT/Contractor PPT/Contractor
Annually	Pollution Prevention Team training Comprehensive annual stormwater evaluation and inspection report	PPT Leader PPT Leader
April	Spring clean-up,	PPT/Contractor
Between November 14 and December 15	Fall clean-up	PPT/Contractor

The Arsenal Project
Operations and Maintenance Plan
Comprehensive Annual Evaluation and Inspection Report

Once a year, the Pollution Prevention Team Leader must inspect and evaluate all aspects and provisions of the Opeations and Maintenance Plan, complete the following report and keep a copy on file at the site.

Inspector/Reviewers:____

Date of Inspection/Review: ____

Note any changes to the Plan in the space below and in the appropriate section of the Plan.

1. Review the Pollution Prevention Team list and update if necessary. Does the Pollution Prevention Team list need updating:
(circle one) Yes No

2. Review the Operations and Maintenance Plan (O&M Plan). Are there sections of the O&M Plan that need updating?
(circle one) Yes No

3. Review Monthly and Weekly Checklists. Update these as necessary

   - Are there any updates needed to Spill and Leak History and/or the checklists?
   (circle one) Yes No

4. Review site drawings and update if necessary
   - Are there updates needed to any of the drawings? (circle one) Yes No
   -

Requested Changes (attach revisions)

The Arsenal Project
Operations and Maintenance Plan
Annual Training Signoff Sheet

For each Operations and Maintenance Plan training session, the Team Leader should keep records of all attending Team Members using the signoff sheet below, as well as the training agenda, notes, etc.

Training Date: ________________________________	**Topic**:
Trainer: ______________________________________	
Team Member Name	**Team Member Signature**

The Arsenal Project
Operations and Maintenance Plan
Weekly Inspection Checklist

The site will be checked each week for trash and debris by a member of the Pollution Prevention Team. If any trash or debris is observed in the specified area, write "yes" in the 2nd column and note the problem and corrective measures taken in the appropriate space. Make a new copy of this checklist each week.

Date: ________________________________ **Checklist completed by**: ______________________________________

GROUNDS AREA TO CHECK	TRASH OR DEBRIS PRESENT?	DESCRIPTION OF PROBLEM	CORRECTIVE MEASURES TAKEN
Parking Lot & Roadways			
Landscaped Areas			
Compactor/Dumpster & Loading Dock Areas			
Perimeter of Property			

The Arsenal Project
Operations and Maintenance Plan
Monthly Inspection Checklist

The following will be checked each month for sources of pollutants by a member of the Pollution Prevention Team. If the condition in the "check for" column is observed, note the problem and corrective measures taken in the appropriate space. Make a new copy of the checklist each month.

Date: ________________________________ **Checklist completed by**: ______________________________________

LOCATION	CHECK FOR…	DESCRIPTION OF PROBLEM (IF PRESENT)	CORRECTIVE MEASURES TAKEN
Loading Dock Areas	Evidence of Spills or Leaks, Spill Response equipment, Trash		
Parking Lot and Paved Areas	Spillage and Trash		
Perimeter of Site	Trash		
Outside Storage Areas (grease, etc.)	Spillage		

The Arsenal Project
Operations and Maintenance Plan
Quarterly Inspection Checklist

The following will be checked each quarter for sources of pollutants by a member of the Pollution Prevention Team. If the condition in the "check for" column is observed, note the problem and corrective measures taken in the appropriate space. Make a new copy of the checklist each month.

Date: ________________________________ **Checklist completed by**: ______________________________________

BMP	CHECK FOR…	DESCRIPTION OF PROBLEM (IF PRESENT)	CORRECTIVE MEASURES TAKEN
Catch Basins	Trash, oil sheen, hood (securely fastened) excessive sediment		
CDS Oil/Particle Separator	Trash, excessive sediment		

The Arsenal Project
Operations and Maintenance Plan
Semi-Annually Inspection Checklist

The following will be checked each quarter for sources of pollutants by a member of the Pollution Prevention Team. If the condition in the "check for" column is observed, note the problem and corrective measures taken in the appropriate space. Make a new copy of the checklist each month.

Date: ________________________________ **Checklist completed by**: ______________________________________

BMP	CLEAN AND REMOVE…	DESCRIPTION OF PROBLEM (IF PRESENT)	CORRECTIVE MEASURES TAKEN
Subsurface Infiltration System	Trash, excessive sediment at inlets		
CDS Oil/Particle Separator	Trash, excessive sediment		

The Arsenal Project
Operations and Maintenance Plan
Annual Inspection Checklist

The following will be checked each quarter for sources of pollutants by a member of the Pollution Prevention Team. If the condition in the “check for” column is observed, note the problem and corrective measures taken in the appropriate space. Make a new copy of the checklist each month.

Date: ________________________________ **Checklist completed by**: ______________________________________

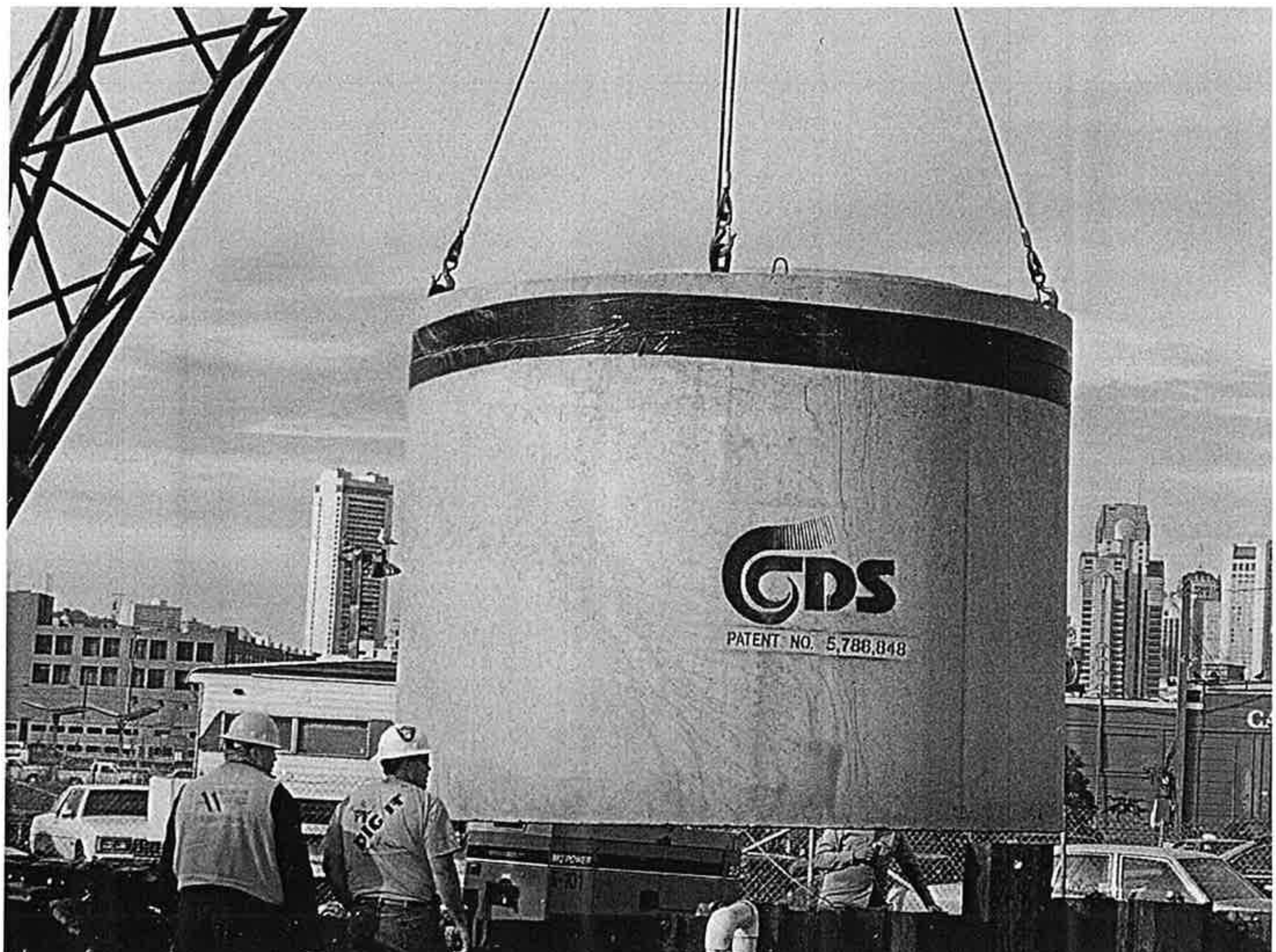
BMP	CLEAN AND REMOVE…	DESCRIPTION OF PROBLEM (IF PRESENT)	CORRECTIVE MEASURES TAKEN
Pollution Prevention Team Training	Prepare annual stormwater evaluation and inspection report		

The Arsenal Project
Long Term Pollution Prevention Plan
Spill and Leak History
(____ to _____)

Date	**Spill**	**Leak**	**Location**	**Description**				**Response Procedures**	**Measures to Prevent Reoccurrence**	**Reporting Pollution Prevention Team Member**
(MM/DD/YY)	*(check one)*		*(as indicated on Site Map)*	*Type of Material*	*Quantity*	*Source, if known*	*Reason*			

CONTECH®
CONSTRUCTION PRODUCTS INC.

CDS® Inspection and Maintenance Guide



CDS TECHNOLOGIES

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

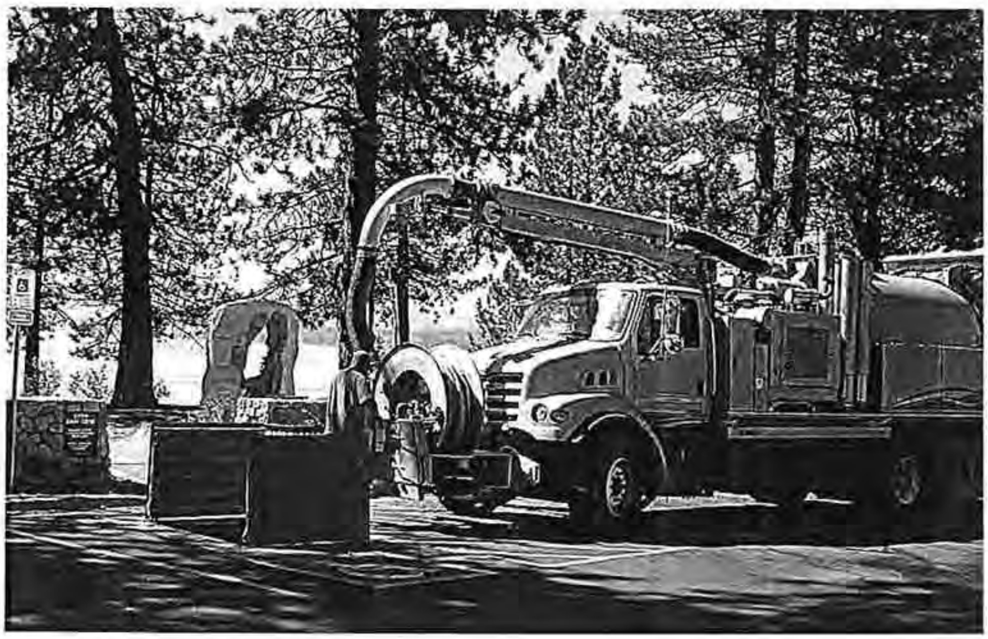
Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	yd3	m3
CDS2015-4	4	1.2	3.0	0.9	0.5	0.4
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities



Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

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CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than eighteen inches the system should be cleaned out. **Note: To avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.